

Twenty Dollars

Cromemco
16K
Extended
BASIC

Instruction
Manual

Cromemco 16K Extended BASIC

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1. Introduction

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1.0

Design Criteria of Cromemco 16K Extended BASIC

Many different versions of BASIC are commercially available from computer manufacturers. These different versions vary greatly in computational precision, programming power, ease of programming, speed of execution, and amount of memory required for the BASIC program. There are a number of BASICs available which are similar in capability to the original BASIC developed at Dartmouth College. These BASICs typically require about 8K of memory. There are also a number of tiny BASICs available that require only 2K of memory but which have different or less capability than an 8K BASIC. For many of today's demanding applications, more features are required than were provided in the original Dartmouth BASIC. A BASIC that provides advanced features and capabilities is frequently called an Extended BASIC. The features included in Extended BASICs also vary widely among computer manufacturers.

Cromemco 16K Extended BASIC (which was developed exclusively for Cromemco by Shepardson Microsystems, Inc.) is designed to maximize computational precision, programming power, and speed of execution by fully utilizing the extensive 158 instruction set of the Z-80 microprocessor.

Cromemco's powerful Extended BASIC was specifically designed to meet the most demanding requirements of business firms (such as inventory and accounting programs) while providing the flexibility and speed necessary for real-time control applications in both industry and the home. A brief review of some of the features included in Cromemco 16K Extended BASIC follows.

One major feature of Cromemco 16K Extended BASIC is rapid, 14-digit arithmetic using the powerful, binary-coded decimal (BCD) arithmetic instructions which are unique to the Z-80 microprocessor. All

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arithmetic operations are performed using the 16 high-speed registers of the central processor for intermediate storage. The speed and precision obtained when performing BCD arithmetic cannot be obtained on 7-register microprocessors such as the 8080. Many BASICs were designed for six or seven digit precision using computer-oriented binary arithmetic. It is possible to do calculations which are as accurate using binary arithmetic as they are using BCD arithmetic. However, many BASICs which use binary arithmetic have introduced highly visible errors when calculating dollar and cent conversions in business and financial programs. These conversion errors cannot occur in BASICs which utilize BCD arithmetic. In addition to arithmetic operations, all functions in Cromemco 16K Extended BASIC are computed to 14-digit accuracy. Many other BASICs that provide 14-digit accuracy do so at greatly reduced execution speeds and often without carrying full accuracy through all subroutines.

Real-time control applications often require integer, 16-bit (4 1/2 digit) arithmetic. Cromemco 16K Extended BASIC provides this capability along with direct memory, input/output, and machine-code subroutine access through BASIC instructions. There is also often a need in real-time control system applications to store large arrays of data. Cromemco 16K Extended BASIC offers the flexibility of allowing the user to manipulate, store, and retrieve six-digit floating point numbers. This abbreviated form of the highly efficient, 14-digit mathematics capability is also slightly faster in execution than the 14-digit format.

Furthermore, in Cromemco 16K BASIC (unlike most microcomputer BASICs), constants used in program lines cause execution speeds as fast or faster than variable references. In addition, integer constants occupy no more room than variable references.

Execution speed is maximized in 16K Extended BASIC by the utilization of a semi-compiling design. The semi-compiling design provides many of the important features of both a compiler and an interpreter. In other words, the properties of a compiler which provide high execution speed are combined with the interactive capabilities and programming ease provided through an interpreter.

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For example, programs may be stopped during execution, examined, and modified. The computer may then be instructed to continue to run the program without affecting the proper execution of the program. The ability to stop, examine, and modify programs can greatly reduce the time and cost associated with computer programming. This interactive capability is not available with optimized compilers. The semi-compiling operation of 16K Extended BASIC is performed after each program line is entered. Any syntax errors are detected at the time of entry rather than during execution. Consequently, the time required to enter and debug a program is reduced substantially.

Some versions of BASIC have either rudimentary or no error message capability. With these versions, if a fatal error causes the program to crash or halt unexpectedly during execution, it is up to the user to reconstruct the failure within the program. Other versions will produce a numerical value after the program fails. This value must be interpreted from a list of error messages. Some more powerful BASIC programs will return an English-language statement explaining the failure after the fact. Cromemco 16K Extended BASIC not only generates English-language error messages, but it also examines each statement as it is entered and prints error messages immediately. The value of such pre-checking, using the error messages, can be pronounced. This capability is extremely important when making corrections to real-time control systems where inadvertent errors in modifications can be costly. In general programming, the interactive aspect of the error messages is extremely convenient and can substantially reduce programming time and errors.

Dynamic error trapping is provided in Cromemco 16K Extended BASIC for specialized routing of program control in response to BASIC generated error conditions. Using the error trapping feature, overflow and underflow arithmetic errors can be handled without operator assistance. The value of this feature in preparing programs that will be used by unskilled operators cannot be underestimated. For instance, should a disk read/write error occur, 16K Extended BASIC can be programmed to type out a message such as: CALL MR. HIGGINS (415-030-1234) IN THE ACCOUNTING DEPARTMENT thereby alerting skilled personnel who can correct

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the problem.

A TRACE feature is provided in Cromemco 16K BASIC to help determine the origin of errors which are difficult to find in a program being written. Line numbers are logged as they are executed with this feature. FOR loops are automatically indented as they are logged in the TRACE mode.

Cromemco 16K Extended BASIC also has advanced floppy disk input/output capabilities. For example, both programs and data may be stored on a disk. Programs may be stored in internal machine (binary) or ASCII format. Numeric and ASCII string data may be stored on a disk using sequential or random access methods. The number of files which may be opened simultaneously is limited only by the amount of memory the user allocates for file purposes, and an unlimited number of files may be opened and closed during the course of a program. Chaining of program segments too large to fit in memory at one time can be performed with parameters passed through disk files or memory. File names can be string variables and can be changed dynamically (at runtime) by the BASIC program. BASIC programs can be written, modified, or run by other BASIC programs. Line numbers can be altered and two programs can be retrieved from the disk and concatenated into one program. The versatility provided through the interaction of the Cromemco Disk Operating System (CDOS) and the disk input/output capabilities of Cromemco 16K Extended BASIC is uncommon.

Many BASICs have string handling capability. However, many of these limit the number of characters that can be stored in the string to a maximum of 255. In Cromemco 16K Extended BASIC, up to 32,767 characters or the available memory space are allowed -- whichever limit is smaller. Substrings are utilized to rapidly manipulate these strings. Again, the design of the language emphasizes speed, versatility, and accuracy. A special, high-speed, string-searching function is provided to increase throughput in string manipulation and sorting operations (such as are commonly found in mailing list processing programs).

Program listings from 16K BASIC are print justified and are uniformly spaced for reading ease and

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clarity of documentation. FOR loops are also automatically nested and indented by the listing function. In the semi-compiling operation, the only statements that are directly stored in memory at entry time are the REM comment statements (and even here spaces are compressed). All other statements are semi-compiled and stored in machine readable format. When listed, this machine readable format is reconverted into ASCII format and then printed. Thus all spacing and other variations are lost in the conversion process. This conversion process allows Cromemco 16K BASIC to efficiently store large programs by storing programs only once in semi-compiled format. In contrast, many other BASICs always maintain an uncompiled, one-to-one representation of what was typed in, along with any internal, execution related storage. Such BASICs require extra program storage if blank spaces are typed inadvertently into the program text. Blank spaces can slow down program execution. Cromemco 16K Extended BASIC does not store, nor is it affected by, inadvertently typed blank spaces. Furthermore, these extra blank spaces are not listed in the program output.

There are a number of features commonly found in most Extended BASICs that are included in Cromemco 16K Extended BASIC. These features include multi-statement lines; one, two, and three dimensional arrays; 26 user-definable functions; advanced formatting capabilities with PRINT USING, TAB, SPACE, and SYS/SET functions; and direct machine language interaction with INP, OUT, PEEK, POKE, and USR instructions. Finally, Cromemco 16K Extended BASIC also has flexible INPUT and PRINT routines which are capable of supporting a wide range of terminals and line printers.

This manual was designed for use both by users who have no prior experience with BASIC and by experienced programmers. Users with little or no prior experience are encouraged to read sections 1.0 through 1.3 and then proceed to Chapter 7, Programming Examples. These examples are designed to introduce Cromemco 16K Extended BASIC to the novice programmer. Chapter 19 is a Glossary and may be consulted if the definition of a term is in question.

Both the beginner and experienced programmer will

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gain insight into BASIC's file structures and access methods by reading Chapter 15, Discussion of Data File I/O.

The advanced user will want to refer to Chapters 17, 18, and 21 (the Appendix) as well as to section 1.4, A Technical Discussion.

1.1 Computers and Computing Power

A computer is a device which performs high-speed mathematical or logical calculations or which processes information derived from coded data in accordance with a predetermined program. This predetermined program is a set of instructions arranged in logical sequence which directs the computer to perform a desired operation.

All computers are based on one fundamental concept -- the binary digit. The binary number system uses only the digits 0 and 1. The binary digit concept is so useful because it can be represented by any device which is capable of assuming one of two possible stable states (on and off). A computer, even in its most complex form, is simply a collection of logic gates which respond to the presence or absence of a voltage. The presence or absence of such voltages, called logic levels, makes it possible to represent binary conditions in a logic circuit. Typically, these logic levels are defined as 0's for off states and 1's for on states.

Binary digits, commonly called bits, can be used to represent numbers of any magnitude by grouping digits together. The primary level at which binary digits are grouped within a particular computer is called word size. Most microcomputers use an 8-bit word size. This 8-bit unit is called a byte. If we consider the various computer words we can make out of all possible combinations of eight bits, we find that there are 2^{8} or 256 possible combinations. We can then build a computer which will respond differently to each byte which we present as an instruction. For example, an instruction of all 0's might mean stop, while 10101010 might mean increment a number by 1. Furthermore, a particular byte might stand for one operation when used with one model of computer and

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might stand for a very different operation in another computer system. The important point is that all computers execute instructions through this binary language which is a combination of on-off states represented by 0's and 1's.

1.2 High and Low Level Languages

As stated in the introduction, a computer must be programmed to perform calculations or to process information. Programs are prepared in a language with precise rules of grammar. Currently available computer languages fall into one of two major categories: high-level or low-level languages. Internally, computers perform various operations according to the binary language described earlier. This binary language is commonly called machine language. Machine language is at the lowest level of computer languages and consists of groups of on and off states. A machine language word is any combination of eight 0's and 1's, (e.g., 01100100). As you can see, it is nearly impossible to tell what a given machine language word means by simply looking at the binary word. Furthermore, programming a computer in this fashion would be both time-consuming and tedious.

To simplify the programming process, some easier method of entering and recognizing instructions is required. The next step in low-level languages then, is an assembly language which uses short mnemonic symbols that assist in the definition of the instruction. An assembly language translates simple instructions, such as HALT or INCREMENT, into the appropriate machine language instructions. But even this form of programming is too cumbersome for many applications. In assembly language, a program to print out "HELLO" on a terminal may require as many as 50 steps. Furthermore, individuals without a great deal of computer expertise often find it difficult to translate problems into a computer program at either the assembly or machine language level.

As a result, higher level languages were developed with instructions and rules of grammar which are easier to learn and apply. Problem-oriented, high level languages include FORTRAN, COBOL, PASCAL, PL/I, and a variety of other languages. These high-

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level languages are translated into machine language through programs called compilers. Any language that must be compiled or translated one or more times before it is reduced to the machine code is said to be a high-level language.

1.3 Basic and Its Uses

Most of the high-level languages mentioned in the previous section were designed for use by special groups comprised of relatively sophisticated computer users. Consequently, most of these languages are somewhat difficult to learn. However, as the computer moved from the design laboratory into the university laboratory and then on into business, home, and school usage, the need for an easy to learn, grammatically simple, English language based, programming language grew. To answer this need, Professors John G. Kemeny and Thomas E. Kurtz of Dartmouth College developed the first version of BASIC in 1965. BASIC is a higher level language which is easy to learn and which can be applied to most computing problems.

In addition to being easy to learn, BASIC has a number of features which make it useful for two very important and common applications: timesharing systems and interactive programming. In BASIC, simple, English language instructions are translated line by line as the program executes into machine code through a program called an interpreter. This interpreter makes it easy to interrupt the conversion process, proceed to another task, and then return to pick up where you left off. Consequently, a computer can be used to allow multiple users running BASIC to timeshare a system. In timesharing, the computer handles each user in some specified sequence. The high speed of the computer, however, makes it appear that all users are being handled simultaneously.

BASIC is also particularly well-adapted for use in interactive programs which require continual user interaction with the computer. Interactive programming allows the user to continually update and revise a program based on intermediate results. For complex problems involving a number of parameters that may require changing before a solution is reached, the interactive programming

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capability is a powerful tool.

Because of these important features, the library of programs written in BASIC, many of them in the public domain, has expanded rapidly. Many complex business programs, including inventory control, payroll, shipping and receiving, and accounting, are available in BASIC. There are programs written for computer assisted instruction (CAI) and for a wide range of interactive games in which users compete with each other or with the computer in simulations of a variety of situations and events.

In addition, the same computer system may be used to streamline accounting procedures, control manufacturing processes, regulate energy usage, or play games. Only the BASIC program need be changed. With the introduction of inexpensive, microcomputer-based, time-sharing systems (such as the multi-user version of the Cromemco System Three Computer), true multi-user computer operation becomes available at only a fraction of its cost five years ago.

1.4

A Technical Discussion of the
Cromemco 16K Extended BASIC Language

A sizable portion of the material in this section will be of interest to those who might be relative novices in the field of system-level programming. Also, it is hoped that more advanced programmers will appreciate the information presented relating to the internals of Cromemco 16K BASIC.

The 16K Extended BASIC Language is an incremental compiler written in Z-80 code by Shepardson Microsystems, Inc. of Cupertino, CA specifically for, and to the specifications of, Cromemco, Inc.

An incremental compiler is a type of interpreter which not only fully checks for correct syntax as the source is being entered, it also immediately resolves any references to undefined items. The primary advantage of the incremental compiler is execution speed. Since variable and line number references are already resolved, no execution time is spent searching tables for items such as a variable name match.

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1.4.1 Syntax Related Tables

As each statement line (or direct command instruction) is entered from the keyboard (or some other I/O device), it is checked for correct language syntax and converted into an internal format. Actually, the routine which does the syntax checking also converts source items into internal tokens at the same time. The BASIC syntaxer is actually driven by a set of syntax tables, the purposes of which are described below.

The Reserved Name Table contains a list of all instruction, function, and operator names that are recognized by BASIC. This table is used to equate the user's ASCII input to a particular internal token. Thus in addition to the reserved name, each entry contains the token to be used.

Main Syntax Table. Once the first reserved name in an instruction has been found, the instruction may be classified as to type. The type directs BASIC to an entry in the main syntax table, where an entry is made up of a list of required and/or optional further items (actually their equated tokens) that must be found in the statement. If a required item is not found in the proper position in the input line, a syntax error is generated. This table is quite complex, as even such things as arithmetic expressions in all their variations must be covered. There are even syntax subroutines included here, so that a statement type may require (for example) a subscripted string name by calling for a subroutine which in turn requires a string variable, a left parenthesis, subscripts, and a right parenthesis. (Please note that this is not actually how the search is performed; it is actually more segmented and more highly organized than stated here.)

The syntax table contains other information about instruction types, such as whether they are allowed in direct mode (a command), within a program (a statement), or both places. It can also declare that an instruction must be the last one in a line or that subsequent instructions on the same line are permitted.

The Binding Strength Table is more properly

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described as a run-time table, since it determines the priority in which operators (+, -, AND, NOT, etc.) are to be executed. It is included here because it is used to relate the internal tokens for the various operators to their priorities.

1.4.2 On Listing a Program

After a program has been converted to internal token form, it is obviously desirable to be able to implement the LIST instruction. On unaltered source types of interpreter, this is simply a matter of dumping the memory contents back out to the list device. In Cromemco BASIC, the problem is significantly more complex. Each token must be reconverted to its ASCII form and (as we shall see later) constants must be reconverted to external format.

1.4.3 Tables in User Program Memory Space

Generally, these types of tables are referred to as runtime tables, though many of them are established at program entry time. They are the fundamental tables which the interpreter uses in executing a user program.

The Statement Table is not strictly speaking a table. It is simply an area of memory where all program lines are stored after they have been converted to internal format. The most distinguishing feature of this table in Cromemco BASIC is that the last line entered is always at the end of the table. Only when a line is deleted or modified is it necessary to slide the table (in order to recover the space occupied by the deleted parts). Also note that the program's line numbers are not stored in the statement table. Instead, the line numbers are found in the line number table.

Line Number Table. This table is also known as the Label Table. Herein are stored the actual line numbers. Also in this table each entry has the address of the beginning of its corresponding program line within the statement table. The third item in each entry in this table is the address

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within the table of the next logical succeeding line (i.e., the line next to be executed unless program flow is altered by a GOTO, GOSUB, or NEXT statement). Note the implication here: even this table is not organized in line number order! As each new line is entered, its label entry is simply appended to the table and the logical successor pointers are updated as needed.

Variable Table. When a variable is first defined (which occurs as the first line using it is entered), an entry is created for it in this table. There are many types of information contained herein. All variables have their name ('A1', 'A\$', 'E') and variable type (string, integer, short or long floating point, and/or array) stored here. In addition, scalar variables (non-array numeric variables) have their actual value stored here. Strings have their dimension and current length stored also. Arrays have the number of dimensions in use noted as well as the maximum value of each dimension. In addition, arrays and string entries contain the address of the actual location of the data for each. The data so addressed is located within the string/array table.

String/Array Table. Again, this table is not so much a table as simply a section of memory reserved for the storage of array and string data. Of the tables mentioned so far, this one is unique in that it is allocated (expanded) at runtime. That is, since statements of the form:

```
310 INPUT J
320 DIM A$(J), B3(J,2)
```

are legal, arrays and strings cannot have their space allocated to them until they are actually dimensioned during program execution.

The For/Next Table. An entry is placed in this table whenever a FOR instruction is encountered. Information kept here includes the address of the corresponding variable table entry, the size of STEP requested (or implied), the terminating TO value, and the address of the entry in the label table corresponding to the line logically following the FOR instruction. If a FOR statement is executed using a variable with an entry already stored in the FOR/NEXT table, the old entry is deleted, the table is adjusted, and the new entry

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is appended.

GOSUB/RETURN Table. A very simple table, this consists simply of the address of an entry in the label table which corresponds to the line logically following the GOSUB statement.

User-Defined Functions Table. Since only user-defined functions FNA through FNZ are allowed in 16K BASIC this is a fixed length table with 26 entries, each active one of which contains the address of the label entry corresponding to the line where the function was defined.

1.4.4 An Example

There follows an actual example of what happens internally to BASIC when a program line is entered (syntax time) and then executed (run time). It is assumed that any existing program and/or data has been removed via a SCRatch command and that the example line shown is the first (and only, though this is not significant) line entered towards creating a new program.

This is the example line:

100 IF A2 = 3.7 THEN 300

1.4.4.1 Syntax Time

The first thing detected is the line number, '100'. This line number is placed in the label table along with the address of the beginning of the statement table (where the encoded line will be stored). Since this is the only entry in the label table, the successor pointer will be set to zero to indicate no successor. Since the label table works from the top down, the pointer to the bottom of the table would be updated to indicate where to place the next entry. So far, then, the label table looks something like this:

2 bytes -- pointer to statement in statement table

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2 bytes -- pointer to successor label (zero, currently)

3 bytes -- the line number, 100, in BCD (5 digits significant)

Next, the keyword 'IF' is encountered and recognized as a valid statement type. It is translated to a single byte internal token and the syntax table entry for 'IF' is accessed. The syntax for 'IF' requires that the keyword be followed by an expression, so the appropriate syntax subroutine is called.

Without going into detail as to what a valid expression is, and how the syntaxer determines that it has or has not encountered one, it is sufficient to note that certainly 'A2=3.7' would be considered valid. That being so, the variable 'A2' makes its first appearance and must be added to the variable table. Its entry would look something like this:

2 bytes -- the variable name (A2)

1 byte -- the variable type, assume a 02, short floating point

4 bytes -- the actual value of the variable, in the length required for its type. This is set to zero until altered.

The statement table would receive a byte signifying that a numeric variable had been found followed by two bytes which are the address of the entry for 'A2' within the variable table.

The equals sign ('=') would be recognized as an operator, and its internal code stored next in the statement table.

The value '3.7' would be recognized as a floating-point constant (integer constants don't have decimal points), and a routine would be called to translate it to internal format. The statement table would receive a byte signifying a particular type of constant (short-floating here) followed, and then the internal constant would be stored.

The 'IF' syntax requires that the expression be followed by a 'THEN' keyword. When it is found,

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its internal token is stored in the statement table.

'THEN' may be followed by either another whole new instruction or (as in this case) by a line number. The processing of this line number is partly what qualifies the Cromemco BASIC interpreter to be called an incremental compiler.

The label table is scanned for a line number '300'. When it is not found, an entry is made for it similar to the one previously made for line '100'. However, for line number 300, the address of its corresponding line in the statement table is set to an illegal value to indicate that it doesn't exist. Later, if a line 300 were entered, the address would be changed to reflect the fact. Also, the entry for line 100 is updated to reflect that its logical successor is line 300 (the next sequentially numbered line).

The statement table receives a token to indicate that a label table address will follow, and then the address of the label table entry for line '300' is stored. Finally, a byte of zero (00) is stored to indicate the end of line.

At this point, then, the statement table will contain the following:

```
1 byte -- token for 'IF'  
1 byte -- token, a variable table address follows  
2 bytes -- the variable table address for 'A2'  
1 byte -- token for '='  
1 byte -- contains 02 hex to indicate that a short floating point constant follows  
4 bytes -- the internal form of the constant '3.7'  
1 byte -- token for 'THEN'  
1 byte -- token, a label table address follows
```

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1. Introduction

2 bytes -- label table address for line number
300

1 byte -- value 00 hex, indicates end of line

1.4.4.2 Run Time

Assume now that the user requested a RUN of the program (and, incidentally, even this simple statement must go through the syntax process before it is executed.)

BASIC searches out the first logical line of the program from the label table and then performs the following steps:

First, the address of the statement within the statement table is found. Then the first byte of the statement is used to vector to the routine responsible for processing IF statements.

The 'IF' processor knows that what follows is an expression, so it calls the expression execution routine to evaluate 'A2 = 3.7'.

The expression evaluator notes that the first item is a variable, so it uses the variable address to extract the value of the variable from the variable table entry for 'A2'. It places this value in an area of memory referred to as the argument stack.

The '=' relational operator (note: this is not the same thing as the assignment operator '=' used in LET instructions) is then pushed onto another BASIC-maintained stack known as the operator stack.

The constant token causes the short floating point constant '3.7' to also be placed on the argument stack.

Since there is no more to the expression, the expression evaluator calls on the processing routine for the equal relational operator. The equality processing routine extracts the two values (contents of 'A2' and the value '3.7') and returns either a one (1) if they are equal or a zero (0) if they are not. The expression evaluator is finished and returns with this value to the 'IF' processor.

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At this point let us examine what happens if the value returned is '1' (which it can't be in our example). The 'IF' processor ignores the 'THEN' token (it has to be there, the syntaxer passed it!) and encounters the label table token. This implies a change in program flow to the line specified in the table entry. So the 'IF' processor simply places the entry encountered in BASIC's own 'next logical statement' location. It then checks to ensure that a line really exists to correspond to the entry. The line does not exist and BASIC issues the error message, GOTO UNDEFINED LINE NUMBER.

Now backtrack a bit and assume that the expression evaluator had returned with a '0' instead (which it would in our example). In this case, the 'IF' processor simply aborts processing of its line and returns to allow BASIC to execute the next logical line. When BASIC encounters the next logical line ('300' in our example) it checks to see if the line exists (it doesn't here) and executes it if it does. If it does not, BASIC ignores the line and falls through to the next logical line. Since line 300 does not exist, and since there is no logical successor, BASIC would print out ***END***.

In Cromemco BASIC, there is no speed penalty for using any and as many variables wherever desired in the program, there is no reason to put certain statements (i.e., subroutines) first in the program, and constants in programs execute as fast or faster than variables.

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2. Instruction Syntax

INSTRUCTION SYNTAX

The Cromemco 16K BASIC language is designed to allow the user to structure and format a program in a wide variety of styles. This section covers the features which allow this flexibility as well as those elements of BASIC syntax which do affect program operation.

2.1 Spaces or Blank Characters

All spaces are optional within 16K BASIC except for those which are included as part of text (i.e., REMarks, string literals and string variables, see sections 4.3 and 5.2). Once a program has been entered in BASIC, the spacing within a listed program will automatically conform to BASIC standards. The following user interaction with BASIC demonstrates both that spaces are ignored on input, and that BASIC stores a program in a standard format.

```
>>1 00PR      INT"This is a string literal"  
>>120REM The spacing within the string literal
```

```
>>130REM and the REMark statements will not be
```

```
>>140REM changed by BASIC.
```

```
>>150FORI=1TO10
```

```
>>160PRINT I ;
```

```
>>170NE XT I
```

```
>>1 80EN D
```

```
>>L IST
```

```
100 PRINT"This is a string literal"
```

```
120 REM The spacing within the string literal
```

```
130 REM and the REMark statements will not be
```

```
140 REM changed by BASIC.
```

```
150 FOR I=1 TO 10
```

```
160 PRINT I;
```

```
170 NEXT I
```

```
180 END
```

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2. Instruction Syntax

2.2 Upper Case Characters

All letters used in Cromemco 16K BASIC must be upper case (capital). The only exceptions to this are string literals, string variables, and REMarks which may contain any printable characters. If any BASIC instruction is entered in lower case letters, a syntax error will result.

2.3 The BASIC Prompt (>>)

When BASIC is ready to accept a command or statement line, it displays a prompt which consists of two greater than symbols (>>). The purpose of the prompt is to indicate that BASIC has finished its last task and is waiting for the user's next instruction.

2.4 Commands

A command is a BASIC instruction which is executed immediately (as soon as the carriage return is depressed). Commands have no line numbers because they are not stored by BASIC.

Cromemco 16K BASIC allows most instructions to be used as commands. For example, BASIC can be used as a calculator while it is in the command mode:

```
>>PRINT 20000/5
4000

>>PRINT (4000+77)/63.
64.714285714285
```

As can be seen, a command may be given whenever the BASIC prompt (>>) is displayed.

In this manual, the term instruction includes both commands and statements. All instructions listed as instructions or commands may be used as commands, while those listed as statements may not be used as commands.

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2. Instruction Syntax

2.5 Statements

A statement is a BASIC program line which contains one or more instructions, and which is stored for execution at a later time. Statements are not executed until the RUN command, or some other command which will begin execution of a program, is given. A statement line has a unique (within a program) line number by which it can be accessed. If a second statement is entered with the line number of a line which already exists, the original line will be replaced by the new line.

Cromemco 16K BASIC allows most instructions to be used as statements. For example, one BASIC program can load and run another BASIC program:

```
100 RUN "PROG2"
```

Execution of this statement will cause PROG2 to be loaded into the User Area and execution to begin.

In this manual, the term instruction includes both statements and commands. All instructions listed as instructions or statements may be used as statements, while those listed as commands may not be used as statements.

2.5.1 Multiple Instruction Lines

Cromemco 16K BASIC allows more than one instruction to be associated with a single line number. Each pair of adjacent instructions must be separated by a colon (:). The number of instructions which may appear on a single line is limited only by the length of a line. For example:

```
100 INPUT A : IF A<0 THEN GOTO 100
200 PRINT SQR(A) : PRINT : PRINT
300 REM LINE 200 WILL SKIP 2 LINES
```

User defined functions (DEF FNs) and DATA statements must appear as a single instruction on a line. The following instructions may appear as part of a multi-instruction line but they must be the last instruction on the line, i.e., no other instruction may follow on the same line.

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2. Instruction Syntax

RUN
REM
GOTO
GOSUB
RETURN
FOR
ON...GOTO (GOSUB)
ENTER
DELETE

A colon may not terminate a multiple instruction line. A colon must be followed by another instruction.

The IF...THEN instruction is unique when followed by other instructions on the same line. The reader is referred to the IF...THEN instruction for a further discussion.

NUMERIC AND STRING

INTERNAL MACHINE REPRESENTATION

Numeric and string alphanumeric information is stored by BASIC in different forms. This section explains these different formats.

3.1

Integer

Integers are whole numbers and in 16K BASIC they must be within the range +32767 to -32768. When stored by BASIC, an integer occupies 2 bytes of memory.

Integer numbers are stored low byte first, high byte second. If the high bit of the high byte is a 1, then the number is negative; if it is a 0, then the number is positive.

A positive number is stored as the binary representation of the number.

A negative number is stored as the 2's complement of the number.

Example:

The number 1234 will be represented by the hexadecimal bytes D2 04 when stored as an Integer. When the order of the bytes is reversed (04 D2) this is the binary equivalent of the decimal number 1234.

The number -1234 will be represented by the hexadecimal bytes 2E FB when stored as an Integer. When the order of the bytes is reversed (FB 2E) this is the 2's complement of the binary equivalent of the decimal number 1234. Because the high bit of the high byte was 1 (before the 2's complement was taken), the number is negative (-1234).

3.2 Short Floating Point

A Short Floating Point number stored by BASIC occupies 4 bytes, has an accuracy of 6 digits, and must be within the range $\pm 9.99 \times 10^{62}$ to $\pm 9.99 \times 10^{-65}$.

The first byte of a Short Floating Point number contains the sign of the number and the exponent in excess $40H$ (64 decimal) notation. If the high bit of the first byte is a 1, then the number is negative; if it is a 0, then the number is positive. Note that this is not the sign of the exponent but rather of the number itself. The remaining 7 bits of the first byte contain the exponent plus $40H$. In order to find the true exponent, $40H$ (64 decimal) must be subtracted from this number.

The remaining three bytes contain the BCD (Binary Coded Decimal) mantissa which has been normalized to a value between 0 and 1. The implicit decimal point is located before the first byte of the mantissa. Each byte of the mantissa can contain 2 significant digits yielding a total of 6 significant digits for a Short Floating Point number.

Example:

The number $-1.2345E+21$ will be represented by the hexadecimal bytes D6 12 34 50 when stored as a Short Floating Point number.

The first bit of the first byte is a 1 indicating that the number is negative. The remaining 7 bits of the first byte (56H or 86 decimal) is the exponent plus $40H$. To get the true exponent $40H$ must be subtracted from 56H. This leaves an exponent of 16H or 22 decimal. This is not the exponent of the original number because the number was normalized. In this example, normalization involved dividing the number by 10^6 and adding 1 to the exponent to compensate for the division.

The remaining three bytes are the BCD representation of the normalized number. BCD stands for Binary Coded Decimal which is a method of representing a decimal number in binary. Using this method, each byte can contain two one digit

decimal numbers. As can be seen from the example, non-significant digits are zero filled.

3.3 Long Floating Point

A Long Floating Point number stored by BASIC occupies 8 bytes, has an accuracy of 14 digits, and must be within the range +9.99+62 to +9.99E-65.

The internal representation of a Long Floating Point number is similar to that of a Short Floating Point number. The difference is that four additional bytes are added to the mantissa for a total of 7 bytes. This is how a Long Floating Point number can maintain 14 significant digits.

3.4 Hexadecimal

A Hexadecimal number occupies two bytes and must be within the range 0H to FFFFH .

The internal representation of a hexadecimal number is the same as that of an Integer. Except for the functions BINAND, BINOR, and BINXOR, hexadecimal numbers are treated as signed integers (refer to section 3.1).

3.5 String

A string is an ordered list of alphanumeric information. Examples of strings include words, sentences, parts of words, groups of letters or special characters.

Elements of a string (characters) stored by BASIC occupy 1 byte each. They are represented internally as an eight bit number which is the ASCII (American Standard Code for Information Interchange) code for the character being stored. Bit number 7 (the high bit) is a parity bit in the ASCII convention and, although it effects string comparisons, it does not effect the character which is PRINTed. Note that although this bit is normally 0 in 16K BASIC, GET and CHR\$ can cause it to be set equal to 1.

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4. Constant and String Literal Formats

CONSTANT AND STRING LITERAL FORMATS

Constants are, as the name implies, unchanging. They each have one value.

String literals are similar to constants in that they each maintain one value which does not change.

This section covers the standard formats for constants and string literals in 16K BASIC.

4.1 Integer and Floating Point Constants

A constant is a number. It does not change value and is represented as it would be in any arithmetic computation.

There are three types of constants: integer, floating point, and hexadecimal. All constants (not specified as hexadecimal) equal to or greater than 10,000 and those containing a decimal point are always stored by BASIC as floating point numbers (either Short or Long Floating Point depending on the current mode, but always Long if there are more than 6 significant digits). All constants (not specified as hexadecimal) with a value less than 10,000 and not containing a decimal point are stored by BASIC as Integer numbers.

Constants

<u>Floating Point</u>	<u>Integer</u>
20000	55
3.	9985
.000376	5
12.7	458

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4. Constant and String Literal Formats

4.1.1 Storage of Floating Points Constants

Floating point constants (1.2, 3., 1E6, etc.) are stored according to the mode which is active when they are entered. An exception is a constant with more than 6 significant digits, which is always stored as a Long Floating Point number. For example, if the active mode is set to Short Floating Point (see the SF MODE instruction) and the following commands are given:

```
>>LONG L  
>>L = 1./3.
```

L will be assigned a value of 0.33333300000000 because 1. and 3. are SHORT (SFMODE was current when they were entered). But, under the same circumstances, if we had said:

```
>>LONG L  
>>L = 1./3.00000000
```

L would have been assigned a value of 0.333333333333 because 3.00000000 is forced to LONG (more than 6 significant digits).

If in the two previous examples, the current mode had been Long Floating Point, L would have received a value of 0.333333333333 in both cases because both 1. and 3. would have been stored as Long Floating Point numbers.

4.2 Hexadecimal Constants

Hexadecimal numbers are used in base 16 arithmetic. The set of digits used in hexadecimal arithmetic is 0 through 9 and A through F.

In Cromemco 16K BASIC, hexadecimal constants are identified by leading and trailing percent (%) signs.

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4. Constant and String Literal Formats

Constants

<u>Hexadecimal</u>	<u>Equivalent</u>
	<u>Decimal</u>
%8000%	-32768
%9000%	-28672
%FFFF%	-1
%9%	9
%A%	10
%F%	15
%10%	16
%80%	128
%FF%	255
%100%	256
%7FFF%	32767

A hexadecimal number is stored in the same format as an integer and may be used wherever a constant is allowed.

4.3 String Literals

A string literal is a string which is enclosed between quotation marks. The quotation marks are not part of the string itself, but are used to delimit (mark the ends of) the string. The value of a string literal does not change.

A quotation mark can be represented within a string literal by the use of two quotation marks, one immediately following the other.

String Literals

```
"This is a string literal"
"Here are imbedded ""quotation"" marks"
"{special} *+- characters are o.k.!"
"-----"
"                just spaces"
```

The trailing quotation mark on a string literal is not required at the end of a line. In this case, the carriage RETURN will terminate, but not be a part of, the string literal.

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5. Variable Representation

VARIABLE REPRESENTATION

Variables are, as the name implies, able to change or vary in value. As a program is executed, variables may be assigned new values at any time. This section covers the standard formats for variables in 16K BASIC.

5.1 Numeric Variables

Numeric variables may be assigned numeric values. The range and accuracy of these variables depends on their type. See Chapter 3 on Numeric Internal Machine Representation for more information.

5.1.1 Format of Numeric Variables

Numeric variables are represented by a single letter (A-Z) or a single letter followed by a single number (0-9). There are 286 possible numeric variable names (A, A0, A1, A2,...,A9, B, B0, B1,...,B9, C, C0, C1,...,Z, Z0, Z1,...,Z8, Z9). In compliance with the rules of 16K BASIC, only upper case letters may be used in variable names.

5.1.2 Integer Variables

Specific variables may be set to Integer by the INTEGER instruction. The default mode for variables may be set to Integer if the IMODE instruction is given before the RUN instruction. Refer to the sections covering Integer Internal Machine Representation, and the INTEGER and IMODE instructions.

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5. Variable Representation

5.1.3 Short Floating Point Variables

Specific variables may be set to Short Floating Point by the SHORT instruction. The default mode for variables may be set to Short Floating Point if the SFMODE instruction is given before the RUN instruction. Refer to the sections covering Short Floating Point Internal Machine Representation, and the SHORT and SFMODE instructions.

5.1.4 Long Floating Point Variables

Specific variables may be set to Long Floating Point by the LONG instruction. Long Floating Point mode is normally the default mode. If the mode has been changed to SFMODE or IMODE, the default mode for variables may be reset to Long Floating Point if the LFMODE instruction is given before the RUN instruction. Refer to the sections covering Long Floating Point Internal Machine Representation, and the LONG and LFMODE instructions.

5.1.5 Matrices and Lists

A matrix is an array of numeric variables in a prescribed form. For example, the array:

```
3 2 0
1 4 6
-3 4 5
```

is a matrix with three rows and three columns. A matrix with m rows and n columns is written:

```
a11 a12 a13 ...a1n
a21 a22 a23 ...a2n
.
.
.
am1 am2 am3 ...amn
```

The individual entries in the matrix are called elements or cells. For example the quantity a_{ij} in the above matrix is the element in row i and column

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5. Variable Representation

j. Subscripts used to indicate elements always denote the row first and the column second. Cromemco BASIC permits the user to define one, two, or three dimensional matrices. A two (i.e., M_{ij}) or three (i.e., M_{ijk}) dimensional matrix is commonly called a table. A one dimensional matrix, a matrix with n columns but only one row, is commonly called a list. For example, the matrix:

3, -1, 5, -8

is a list (or a matrix) with one row and four columns.

A matrix may be defined to be composed of Long or Short Floating Point or Integer variables.

5.1.5.1 Format

A matrix is named in the same manner as a numeric variable. A specific element of a matrix is accessed by the matrix name followed by 1, 2, or 3 indices enclosed in parentheses. These indices may be numeric expressions, variables, or constants.

Singly dimensioned matrices are implicitly dimensioned as 10. Larger singly dimensioned as well as 2 and 3 dimensional matrices must be explicitly dimensioned by the DIMension, INTEGER, LONG, or SHORT instruction.

An element of a matrix may be used anywhere a variable is allowed.

5.2 String Variables

String variables may be assigned alphanumeric values. This includes all letters (both upper and lower case), numbers, and all printable and non-printable characters. Refer to the section on String Internal Machine Representation for more information.

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5. Variable Representation

5.2.1 Format

String variables are represented by a single letter (A-Z) followed by a dollar sign (\$) or a single letter followed by a single number (0-9) followed by a dollar sign. In compliance with the rules of 16K BASIC, only upper case letters may be used in string variable names. Some examples of string variable names are:

A\$
A5\$
Q0\$
M\$
M1\$

5.2.2 Dimensioning String Variables

There is, for most purposes, no limit to the size (i.e., number of characters) of a string literal that may be assigned to a string variable. However, the default value in 16K BASIC for string size is 11 or fewer characters. If string values of more than 11 characters are to be assigned to a variable, the string variable must be DIMensioned. The DIM statement is used in BASIC to define the size of a string variable (see the description of DIM in Chapter 11).

Example:

10 DIM A1\$(20), B\$(30), C4\$(40)

In this example, the string variable A1\$ is dimensioned to allow for strings up to 21 characters in length, the variable B\$ is dimensioned to allow up to 31 characters, and C4\$ is dimensioned for up to 41 characters. Any string value assigned to a variable which exceeds the specified dimension is truncated. Consequently, the programmer should be sure to dimension string variables to handle the largest string which will be input.

Note: DIM A\$(20) allows a 21 character string because string bytes are numbered from 0 through the specified DIM size. Remember that using the 0th element of strings (and arrays) can save memory space.

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5. Variable Representation

A string of length zero is called a NULL string.

5.2.3 Referencing String Variables

String variables may be referenced (for input, output, manipulation, or comparison) in their entirety or by parts (substrings). For example, if the string variable A\$ equals "SUBSTRING EXAMPLE", substrings of A\$ include "SUB", "UBSTR", "G EXA", and any other part of the string.

Substrings are referenced by subscripting string variables. The four formats for referencing string variables are discussed here. In these formats svar refers to a string variable name (refer to section 5.2.1) and aexp-1 and aexp-2 are arithmetic expressions, variables, or constants. If the string variable has not been explicitly DIMensioned, it can be considered to have an implicit DIMension of 10.

5.2.3.1 Format-1: svar

On input (INPUT or GET), if a string variable is referenced without subscripts, the entire string is referenced by implication. This means that all characters, 0 through the DIMension of the string are referenced. On output (PRINT or PUT), if a string variable is referenced without subscripts, the string is referenced from the first character (character number 0) through the last non-null character. This is the same as saying that the string is referenced from character number 0 for a length LEN (see the LEN string function).

Summary -

On input, if no subscripts are used, the entire string variable is referenced as dimensioned.

On output, the string is referenced from character 0 through the last non-null character.

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5. Variable Representation

5.2.3.2 Format-2: svar(aexp-1)

If a single subscript is used it must be greater than zero and less than or equal to the DIMension of the string variable. This format defines a substring which starts with the character in position aexp-1 and includes all subsequent characters in the string through the DIMensioned value (input) or through the last non-null character (output). If, on output, a character position greater than the LENGTH of the string is explicitly referenced, then all subsequent null characters are referenced by implication.

If aexp-1 is less than zero, the entire string will be referenced (character 0 through the DIMensioned value).

If aexp-1 is greater than the DIMension of the string variable, a run time error message will result.

Summary -

If one (aexp-1) subscript is used, the substring referenced starts with character in position aexp-1 and includes all subsequent characters in the string through the DIMension value (input) or through the last non-null character (output).

$0 < aexp-1 \leq \text{DIMension of svar}$

5.2.3.3 Format-3: svar(aexp-1,aexp-2) aexp-2 ≥ 0

In this format, aexp-1 must be greater than or equal to zero and less than the DIMension of the string variable. Thus, aexp-1 defines the starting character of the substring as it did in format-2.

The second subscript (aexp-2) must be greater than the first subscript (aexp-1) and less than or equal to the DIMension of the string variable. Now, aexp-2 defines the final character of the substring.

If either aexp-1 or aexp-2 exceeds the DIM value of the string variable, a run time error will result.

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5. Variable Representation

If aexp-1 is less than zero, the entire string is referenced as though no subscripting had been used (see format-1).

If aexp-2 is less than aexp-1, aexp-1 will be the starting character of the substring and the DIMensioned value will be the final character (as though format-2 had been used with aexp-1).

Refer to format-4 if aexp-2 is less than zero.

Summary -

If two subscripts (aexp-1, aexp-2) are used, the second subscript being positive, the substring referenced starts with character in position aexp-1 and ends with character in position aexp-2.

$0 \leq aexp-1 < aexp-2 < \text{DIMension of svar}$

5.2.3.4 Format-4: svar(aexp-1,aexp-2) aexp-2 < 0

In this format, aexp-1 must be greater than or equal to zero and less than the DIMension of the string variable. Thus, aexp-1 defines the starting character of the substring as it did in format-2 and format-3.

The second subscript (aexp-2) must be less than zero and its absolute (positive) value must, when added to aexp-1 not exceed the DIMensioned value of the string variable. In this case, the absolute (positive) value of aexp-2 indicates the length or number of characters included in the substring.

If aexp-1 plus the absolute value of aexp-2 minus one is greater than the DIMensioned value of the string variable, a run time error will result.

If aexp-1 is less than zero, the entire string is referenced as though no subscripting had been used (see format-1).

Refer to format-3 if aexp-2 is equal to or greater than zero.

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Summary -

If two subscripts (aexp-1, aexp-2) are used, the second subscript being negative, the substring referenced starts with character aexp-1 and continues for a length of |aexp-2|.

$0 \leq aexp-1 < \text{DIMension of svar}$
 $aexp-1 + |aexp-2| \leq \text{DIMension of svar}.$

Note:

If aexp-2 is equal to $\%8000\%$ then aexp-2 is considered to be equal to -0 (minus zero) and will produce a string of length zero (i.e., a null string).

Examples:

Assume that the command $A\$ = "ABCDEFGHIJK"$ has been given and that the string variable $A\$$ has not been DIMensioned in a DIMension instruction (it is implicitly DIMensioned at 10 and it contains 11 characters numbered zero through ten).

<u>Instruction</u>	<u>Result</u>	<u>Explanation</u>
PRINT A\$	ABCDEFGHIJK	Format-1 was used to PRINT the entire string.
PRINT A\$ (5)	FGHIJK	Format-2 was used to PRINT the substring starting with character 5 (remember that the characters are numbered starting with 0).
PRINT A\$ (4,8)	EFGHI	Format-3 was used to PRINT the substring starting with character 4 and ending with character 8.
PRINT A\$ (3,-2)	DE	Format-4 was used to PRINT the substring starting with character 3, for a length of two characters.

Now assume the command $A\$ = "ABCDEFG"$ has been given. This will fill the string with the seven characters A-G and 4 null characters. In the following examples the lower case n represents a null character.

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5. Variable Representation

<u>Instruction</u>	<u>Result</u>	<u>Explanation</u>
PRINT A\$	ABCDEFG	Format-1 was used to PRINT character 0 through the first non-null character.
PRINT A\$(-1)	ABCDEFGnnnn	Format-2 (with a negative argument) was used to PRINT characters 0 through DIM.
PRINT A\$(8)	nnn	Format-1 was used to PRINT characters 8 through 10. Note that character 8 is greater than the LENGTH of A\$ so that all succeeding nulls are referenced by implication.
PRINT A\$(5)	FG	Format-2 was used to PRINT character 5 through the last non-null character.
PRINT A\$(5,2)	FGnnnn	Format-3 was used with aexp-2<aexp-1 so the string was output from character 5 through the DIMension of the string.
PRINT A\$(8,9)	nn	Format-3 was used to output characters 8 through 9.
PRINT A\$(13,15)		Format-3 error, aexp-1>DIM.
PRINT A\$(3,%8000%)		A length of -0 indicates a null string, no string is output.

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OPERATORS

An operator is a symbol or group of letters which indicate that an action is to be taken on one or two items. This section describes the types of operators used in 16K BASIC and the symbols which represent them.

6.1 Arithmetic Operators

The arithmetic operators are analogous to their algebraic counterparts:

Arithmetic <u>Operator</u>	<u>Meaning</u>
+	plus sign (positive number)
-	minus sign (negative number)
** or ^	exponentiation
*	multiplication
/	division
+	addition
-	subtraction

Arithmetic operations in a numeric expression are performed, according to the priority of the operation, from left to right. All operations enclosed within parentheses are performed first. When multiple sets of parentheses appear, the operations in the innermost set of parentheses are performed first, followed by the operations in the next set of parentheses, and so on until the operations in the outermost set of parentheses are evaluated. Following evaluation of expressions enclosed in parentheses, arithmetic operations are performed in the following order: plus and minus signs (unary operators), exponentiation, division and multiplication (these two operations have the same priority), and addition and subtraction (these

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operations also have the same priority). When operations have the same priority, calculations are performed from left to right within the expression. The use of parentheses can alter the order in which operations are performed since the parentheses override both the left to right priority and the normal order of operations.

Examples:

A + B * C ** D

The above expression will be evaluated as follows:

```
temp = C ** D
temp1 = temp * B
final value = temp1 + A
```

The order of association can be changed by the use of parentheses:

((A + B) * C) ** D

This expression will be evaluated as follows:

```
temp = A + B
temp1 = temp * C
final value = temp1 ** D
```

It is a good idea to use parentheses if there is any doubt as to the order in which a series of operations will be performed. Intermediate results may also be assigned to temporary variables if this will help to clarify the order of operations.

6.2 Assignment Operator

The equal sign (=) is the assignment operator. It is used to assign the value of an arithmetic, relational, or boolean expression, or a function, to a numeric variable.

In addition, the assignment operator is used to assign the value of a string literal, string variable, or string function to a string variable.

BASIC also uses the equal sign as a relational operator (see the following section). The only place the equal sign is a legal assignment operator

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is the first equal sign in a LET, implied LET, or MAT instruction.

Examples:

```
100 A = 2
110 PRINT A
120 A = A*2
130 IF A = 16384 THEN STOP
140 GOTO 110
```

This program will print out all of the powers of 2 which are less than 16384 and then it will stop. Statement 100 assigns the value of 2 to the numeric variable A.

Line 120 assigns the result of the multiplication of the variable A times the constant 2 to the variable A. This is a good example of the reason the term assigned to is used instead of equal to. A is obviously not equal to A times 2. The expression on the right side of the assignment operator is evaluated (A * 2) and then this value is assigned to the variable on the left of the assignment operator.

Statement 130 uses the equal sign as a relational operator. The relational expression (A=16384) is evaluated as true or false. If it is true, the portion of the instruction following THEN is executed (program execution STOPs). If it is false, the next succeeding statement (140) is executed. Refer to the following section for a further discussion of relational operators.

Line 140 transfers control back to line 110 and execution continues until the relational expression (A = 16384) is true.

```
10 A$ = "END"
20 PRINT "Enter a name,"
30 PRINT "END to stop";
40 INPUT G$
50 IF G$ = A$ THEN STOP
60 PRINT G$ : PRINT
70 GOTO 20
```

Statement 10 assigns the value of the string literal "END" to the string variable A\$. Line 40 gets a string from the user and assigns the value of that string to the string variable G\$ after

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having set G\$ equal to a string of null characters (see the INPUT instruction).

Statement 50 uses the equal sign as a relational operator. The relational expression (G\$ = A\$ or we could have used G\$ = "END") is evaluated as true or false and the execution of the program continues on the basis of the evaluation. See the next section for more on relational operators.

6.3 Relational Operators

<u>Relational Operator</u>	<u>Meaning</u>
=	is equal to
<	is less than
>	is greater than
<=	is less than or is equal to
>=	is greater than or is equal to
<> or #	is not equal to

Relational operators are used to compare two expressions. Each of these expressions may be composed of other relational, boolean, or arithmetic expressions. This allows the user to nest relational and boolean expressions.

In addition, relational operators are used to compare string variables, string literals, and string functions with each other.

The result of a relational operation is either true (=1) or false (=0).

Examples:

```
100 IF A<=0 GOTO 150
110 PRINT A=0
120 B=A<0
130 C=A=5
150 END
```

Statement 100 can be read as, "If the value of the

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variable A is less than or is equal to zero, transfer program control to line 150; otherwise continue with the next statement (line 110)". This is the most common use of a relational operator. This statement can be used to test the validity of user input, transferring control to another section of code if the input is not as desired.

Statement 110 may at first look like an improper assignment instruction. Remember that the equal sign is, in this case, a relational operator, not an assignment operator. This statement can be read as, "Compare the value of A with 0 and print the result of the comparison". Thus, a zero (=false) will be output if A is not equal to zero and a 1 (=true) will be output if A is equal to zero.

Statement 120 is similar to 110, with the exception that the result of the relational comparison is assigned to the variable B. B will therefore take on a value of 0 or 1.

Statement 130 is a combination of the procedures used in 110 and 120. Remember that the first equal sign is an assignment operator while the second equal sign is a relational operator. This statement can be read as, "Compare the value of the variable A with five and assign the result of that comparison to the variable C". C will take on the value of 1 (=true) if A is equal to five, otherwise C will be set equal to 0 (=false).

```
300 S$ = "zzz"  
305 INPUT Q$  
310 IF Q$ > S$ THEN GOTO 305  
315 S$ = Q$  
320 PRINT S$  
325 GOTO 305
```

Line 300 initializes the string variable S\$ by filling it with z's (the alphabetic character with the highest value in the ASCII collating sequence). Line 305 requests string data from the user.

Statement 310 evaluates the relational expression (Q\$>S\$) on the basis of the ASCII collating sequence (refer to the table of ASCII characters in the appendix). If the first character in the string Q\$ is different from the first character in the string S\$ then these characters are compared and this relationship determines the relationship

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of the two strings. If the first character in each string is identical to the other, the comparison moves on the second character and so on. For example:

<u>Value of Q\$</u>	<u>Value of S\$</u>	<u>Value of Expression</u> <u>Q\$>S\$</u>
George	Fred	false
Fred	April	true
April	Ted	false
april	Ted	true
april	ted	false
april	apron	false
april	apricot	true
april	aprilandmay	false

Notice that all lower case letters follow the set of upper case letters in the ASCII collating sequence and that if two strings are the same except for length, the longer string has a greater value than the shorter one.

Continuing with the example, if the relational expression (line 310) is evaluated as true, control is transferred to line 305 and the user is asked for another string. If the expression is false, this means that the string which was just INPUT by the user is closer to the beginning of the ASCII collating sequence than any other string which had been INPUT previously. The value of this string is then assigned to the string variable S\$ so that all strings which are INPUT following this one can be compared with it. The value of the string is then PRINTed and control is transferred to line 305. Execution of this program may be terminated by depressing the ESCape key.

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6.4 Boolean Operators

<u>Boolean Operator</u>	<u>Meaning</u>
AND	logical AND
OR	logical OR
XOR	logical eXclusive OR
NOT	logical NOT or negation

Boolean operators perform a logical operation on one or two expressions. The expressions in a boolean operation may take on one of two values: false ($=0$) or true ($=1$). In Cromemco 16K Extended BASIC, all values which are not equal to zero (false) are considered to be true ($=1$) when used with boolean operators.

AND Boolean Operator

The AND boolean operator compares two logical values and if both are 1 returns a result of 1. If both values are not 1, then the result is 0.

Truth Table

AND	0	1
0	0	0
1	0	1

OR Boolean Operator

The OR boolean operator compares two logical values and if either or both are equal to 1 then the result is 1. Otherwise the result is 0.

Truth Table

OR	0	1
0	0	1
1	1	1

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XOR Boolean Operator

The XOR boolean operator returns a 0 if the logical values are identical and a 1 if the logical values are not identical.

Truth Table

XOR	0	1
0	0	1
1	1	0

NOT Boolean Operator

The NOT boolean operator returns the compliment of any logical value. In other words, if the logical value is 1, the NOT operator returns a 0. If the logical value is 0, a 1 is returned.

NOT Truth Table

NOT 0 is 1

NOT 1 is 0

Examples:

```
10 A = 1 : B = 0 : A1 = 1 : B1 = 1
11 IF A AND A THEN PRINT "11 TRUE"
12 IF NOT A THEN PRINT "12 TRUE"
13 IF NOT B THEN PRINT "13 TRUE"
14 IF A XOR A THEN PRINT "14 TRUE"
15 IF NOT (A XOR A) THEN PRINT "15 TRUE"
16 IF A OR B THEN PRINT "16 TRUE"
```

The statements above give some examples of the use of boolean operators. The IF...THEN instructions are used in these examples to test if a given boolean expression is true or false. If the expression is true, the PRINT instruction following the IF...THEN is executed. If it is false, then nothing is printed.

The results of each of these expressions can be determined from the preceding truth tables. For example, line 14 uses the XOR operator to compare two true (=1) values. Looking at the XOR Truth Table, it can be seen that a 1 and a 1 yield a 0 or false value. Line 15 negates this same expression.

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Looking at the NOT Truth Table, NOT 0 (Not false) is seen to be equal to 1 or true.

The results of the rest of the examples can be determined in a similar manner, then tested on the computer.

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PROGRAMMING EXAMPLES

The examples in this chapter are intended for the first time user. They explain in step by step detail the procedures for creating, editing, and saving a BASIC program. If a more detailed description of a BASIC instruction is required, the reader is referred to the chapters of this manual which cover the instructions on an individual and in depth basis.

It is recommended that the novice BASIC user go through this section while seated in front of a terminal, with BASIC up and running. This way, each instruction and program can be tried out as it is presented.

When BASIC is loaded into a minimum disk system configuration with 32K bytes of memory, the space available to the user should be 1.5K bytes. The other 30.5K bytes are occupied by BASIC, the console processor, CDOS I/O routines, etc. For ways to increase the user space, see the notes at the end of the manual, specifically: Changing the Number of I/O Channels.

Note: It is important to remove disks from the disk drive before turning the power on or off. This will eliminate the possibility of stray bits being written on the disk as the system is powered up or down.

7.1 Getting Started

After the computer has been turned on, the floppy diskette containing BASIC and the Cromemco Disk Operating System (CDOS) must be inserted into disk drive A. This is the leftmost disk drive. Start with the diskette supplied by Cromemco. The diskette should be inserted so that the label faces left and the edge with the elongated hole which exposes the surface of the diskette is toward the

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rear of the machine (disk drive). If there is a door on the disk drive it must be closed after the diskette is inserted.

Next the RETURN key on the console must be depressed several times so that the computer can determine the speed at which the console is sending characters (baud rate). The computer will respond to this by displaying a character on the console (called a prompt) which indicates that it is waiting for the user to type something. If the prompt is a semicolon (;), the user must type B (for Boot) followed by a carriage RETURN to load CDOS into memory. If the prompt is the letter A followed by a period (A.) then the Cromemco Disk Operating System (CDOS) has already been loaded into memory.

The terminal must be set up so that it will only send BASIC upper case characters. If you are using one of the Cromemco 3100 series terminals, depress the ALPHA LOCK key so that the red light on the key is lit. You will now be in upper case mode.

In response to the CDOS prompt, type BASIC followed by a carriage RETURN. After a few seconds the BASIC sign on message will be displayed followed by the BASIC prompt (>>). BASIC has now been loaded into the computer's memory and is waiting for instructions.

One Very Important Point follows:

ALL LINES ENTERED IN BASIC MUST BE TERMINATED BY DEPRESSING THE CARRIAGE RETURN KEY.

BASIC will never respond to an instruction, accept any input, or complete a command unless it is terminated by a carriage RETURN. If BASIC does not seem to be responding as you think it should, make sure that you have properly terminated the current line (with a carriage RETURN).

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7.1.1 The Command or Immediate Mode

Whenever the BASIC prompt (>>) is displayed, BASIC is in the Immediate Mode. This means that an instruction (command) can be entered and BASIC will respond immediately after the carriage RETURN is depressed.

The first instruction we will discuss is PRINT. PRINT causes BASIC to display the information following the word PRINT. Using only the PRINT instruction, and the standard Arithmetic Operators (+ for addition, - for subtraction, / for division, and * for multiplication), BASIC may be used as a calculator.

<u>Instruction</u>	<u>Explanation</u>
PRINT 5	This will PRINT the number 5. Since there is nothing following the 5 BASIC will add a carriage RETURN and LINE FEED so that the next item which is PRINTed will start in column 0 of the following line.
PRINT 7 + 4	This will PRINT the result of adding 7 and 4, or 11.
PRINT "FRED"	This will PRINT the word FRED. Notice that if a group of letters (called a string) are to be PRINTed, they must be enclosed in quotation marks. When a string is enclosed in quotation marks, it is called a string literal. Numbers (called constants) which are to be used in a computation may not be enclosed in quotation marks.
PRINT	This will PRINT a blank line.
PRINT 1,2,3,4	This will PRINT the numbers 1 through 4 in four columns across the screen. When commas (,) are used to separate items in a PRINT list, the items are aligned in four columns across the console screen. If

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semicolons (;) are used, the items are displayed with no intervening spaces.

PRINT "ANS. = ";75 This will display ANS. = 75 on the console. Notice that a blank was included after the equal sign in the string literal. This blank is considered part of the string literal, just as any other character.

Next we will discuss variables and the Assignment Operator (Instruction). A variable is the name of a location in the computer's memory. While the name of a variable stays the same, the contents of the variable (location) may vary.

A variable name may be thought of as a label which has been affixed to a box. If we are speaking of an arithmetic variable, then the box would contain a number. The number inside the box is the VALUE of the variable. The value of the variable can be changed while the name of the variable stays the same. Similarly, a string variable would contain a string of characters which could include letters, spaces, numbers, and any other printable characters. This combination of characters would be the value of the string variable.

Arithmetic variable names are composed of either a single letter (A-Z) or a single letter followed by a single number (0-9). Some examples of arithmetic variables are A1, B8, Z0, Q4, V, A, etc.

String variables may use any name which is a legal arithmetic variable name, however, a dollar sign must immediately follow the name. Some examples of string variables are G8\$, Y\$, P\$, T1\$, M9\$, etc.

The assignment operator assigns a value to a variable. The equal sign (=) is used for this purpose. In BASIC, the equal sign can be read as, "is assigned the value of". Notice that it does not necessarily denote equality.

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<u>Instruction</u>	<u>Explanation</u>
G\$ = "FRED"	The value of the string literal "FRED" is assigned to the string variable named G\$. Notice that, although the string literal "FRED" must be enclosed in quotation marks, the quotation marks are not part of the string variable. The quotation marks indicate to BASIC that the enclosed characters are to be considered a string literal.
PRINT G\$	This instruction will display the value of G\$ on the console. If this instruction follows the preceding one, FRED will be PRINTed on the console terminal.
P4 = 775	The variable named P4 is assigned the value of 775.
P4 = P4 + 1	P4 is assigned the value of P4 + 1. If this instruction follows the previous one, P4 will have the value of 776.
Q5\$ = " IS NO. "	The string variable Q5\$ is assigned the value of the string literal " IS NO. ".
Z7\$ = Q5\$	The string variable Z7\$ is assigned the value of the string variable Q5\$.
PRINT G\$; Z7\$; P4	will print FRED IS NO. 776 (assuming it follows the above assignment instructions).

An important distinction: The user must be careful to distinguish between a string literal and the name of an arithmetic variable. The following table should help to clarify this difference.

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<u>Instruction</u>	<u>Explanation</u>
A = 54	The variable named A is assigned the value of 54.
PRINT A	This will PRINT the number 54 which is the value of the arithmetic variable A.
PRINT "A"	This will PRINT the letter A which is the value of the string literal.

The next instruction we are going to discuss is the INPUT instruction. When executed, this instruction displays a question mark on the console and waits for the user to supply a number or a string.

<u>Instruction</u>	<u>Explanation</u>
INPUT A	This command will display a question mark and wait for the user to enter a number. The number which is entered will be assigned to the variable named A.
INPUT Q\$	This command will display a question mark and wait for the user to enter a string (any group of characters, in this case up to a maximum of eleven). The value of the string which is INPUT will be assigned to the string variable named Q\$.

7.1.2 The RUN or Program Execution Mode

Up to this point, all of our examples have been executed as commands or in what is referred to as the immediate mode. Each command was executed as soon as the carriage RETURN was depressed. Once executed, the entire instruction had to be typed again in order to be re-executed.

Now we shall use these same instructions to write a program. A program consists of statements. A

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statement is nothing more than an instruction with a line number preceding it. Line numbers are also called statement numbers; the two terms are interchangeable. The line number indicates to BASIC that the instruction is to be stored in memory for later execution. A line number is also a handy way to refer to a BASIC statement if it needs to be changed.

Let us enter a program:

```
>>100 INPUT A$  
>>200 PRINT A$; " is smart!"
```

This program is now current in the User Area. The User Area is the BASIC workspace in which a program can be written, edited, and run. The LIST command displays the contents of the User Area.

The RUN command causes BASIC to execute the program in the User Area. Program execution begins with the statement with the lowest line number and continues sequentially.

Now, we can execute the program:

```
>>RUN  
? Tom          BASIC displays the ? (prompt)  
               and the user enters a string.  
               Don't forget the carriage  
               RETURN at the end of the  
               string!  
  
Tom is smart!  BASIC PRINTS the string  
               variable (Tom) and the string  
               literal ( is smart!).  
  
***END***      BASIC tells you that it's done  
               with the program,  
  
>>          and that it is ready for  
               additional instructions.
```

To get a LISTing of your program, type the command LIST in response to the BASIC prompt.

```
>>LIST  
100 INPUT A$  
200 PRINT A$;" is smart!"  
  
>>
```

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7.1.3 Activating the System Printer

The printer (if one is attached to your system) is activated by typing control-P. Control-P is typed by holding down the CTRL key on your terminal (as you would hold the shift key on a typewriter) and simultaneously depressing the P key.

Anytime CTRL-P is typed, the system printer automatically echoes any input, output, or LISTing which is sent to the console.

To LIST the program which is current in the User Area, enter:

>>LIST (CTRL-P) (CR)

on the console. The LISTing will be sent to the console as well as the printer. When the LISTing has terminated, type CTRL-P before anything else is entered. This will ensure that nothing else is output to the printer following the LISTing.

Anytime the printer is on and is echoing the console, typing CTRL-P will turn off the printer.

If CTRL-P is inadvertently typed, and there is no system printer, or the printer is off, type a second CTRL-P to resume normal operation. If this is not done, the system will wait for a printer before displaying any additional output on the console.

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7.1.4 Program Editing

Continuing with the same program, we wish to alter a statement.

To change a line, type it over again. When BASIC recognizes that it already has a line with the same line number, it will replace the old line with the new one. To delete a line, type the line number followed by a carriage RETURN. Suppose we wanted to change line 200:

>>200 PRINT A\$; " is very smart!!!"

>>LIST After making the change, we can list the program to make sure that we changed it properly.

100 INPUT A\$
200 PRINT A\$;" is very smart!!!"

>> Again, BASIC waits for further instructions.

Suppose that, instead of executing these statements only once, we wanted them executed several times. We could type RUN each time the program was to be executed, or we could add another statement which would direct BASIC back to the beginning of the program each time it finished PRINTing:

>>300 GOTO 100 This GOTO tells BASIC to GOTO statement number 100 and continue executing from there.

>>LIST
100 INPUT A\$
200 PRINT A\$;" is very smart!!!"
300 GOTO 100

>>RUN
? Alice Don't forget the carriage RETURN!

Alice is very smart!!!

? Eileen After it was done with statement 200, statement 300 told BASIC to go back to statement 100, which gave us another question mark.

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Eileen is very smart!!!

? This could (and would) go on forever. This can be avoided by depressing the ESCape key (appropriately named). On a Cromemco terminal this key is located on the upper left of the keyboard and is marked ESC.

100 ESCAPE

>> BASIC tells you what happened, and waits for further instructions.

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7.2 Example Program One

Let's write a program to compute a person's age in the year 1985. For this program, we will introduce two new instructions. The first of these is SCR which is short for SCRatch. This instruction clears memory of a program or any statements which may be in the User Area:

>>SCR

>>LIST Nothing will be listed, because everything has been SCRatched!

>>

The other is AUTOL which is short for AUTOmatic Line numbering. This is a convenient feature of Cromemco 16K BASIC which allows the programmer to concentrate on the program and forget about entering line numbers. AUTOL is followed by two numbers (called arguments). The first of these indicates the first line number, while the second indicates the increment between line numbers. In the following example, the line numbers are automatically typed by BASIC while the program is entered by the user:

```
>>AUTOL 1000,10

>>1000 PRINT"Enter the year of your birth: ";
>>1010 INPUT Y
>>1020 PRINT"In 1985 you will be ";1985-Y;" years old"
>>1030 PRINT
>>1040 GOTO 1000
>>1050
>>
```

There are several things about this program which bear discussion. The first is that the AUTOmatic Line numbering mode may be terminated by entering a carriage RETURN (our old friend) in response to a line number. Line 1020 PRINTs two strings with a number in the middle. The number is the result of a computation: the numeric variable Y is subtracted from the numeric constant 1985. Line 1030 is included so that there will be a blank line PRINTed between examples.

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7.2.1 LISTing to a Disk File

The program we have written will stay in memory (in the User Area) as long as we don't execute the SCRatch command or turn the power off.

We may write the program to a disk file so that it may be retrieved at a later time. Once it has been LISTed on the disk, we may SCRatch the user area or turn the power off and our program will still be safe on the disk.

The only way a disk file can be destroyed is by ERASing it or by writing another file with the same name to the disk. In the latter case, the second file would be written over the first so that the first file would be destroyed.

The LIST command, as we have been using it, LISTS the contents of the User Area to the console. If the LIST command is followed by a string literal, BASIC will interpret the string literal as a file name, and LIST the contents of the user area to that file. Assuming that our program is still in the User Area, the following command will write the program to a file called FIRST.

```
>>LIST "FIRST"
```

```
>>
```

The disk should come to life, click once or twice, and another prompt should appear on the console. If BASIC has done your bidding, the DIRectory command will reveal a file on the disk called FIRST. To get a list of all the files on the disk enter the command:

```
>> DIR
```

BASIC will respond with a list of file names, including FIRST. Now you can shut off the computer without losing your program.

Remember to remove the disk before turning the power off. It is also a good idea to insert the disk only after the power has been turned on. Do not turn the power on or off while the disk is inserted in the machine.

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7.2.2 ENTERing from a Disk File

A program which has been LISTed to a disk file may be re-entered by using the ENTER command.

Before entering any program, whether from a disk file, or from the console, it is a good idea to SCRatch the User Area. Assuming that we are once again (or still) in BASIC, we can give the following two commands to clear the User Area and enter our program which was saved in the disk file FIRST.

```
>> SCR  
>> ENTER "FIRST"  
>>
```

Our program may now be LISTed, RUN, or modified as we desire.

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7.3 Example Program Two

Let's try another example. First we will type SCR to clear the user area, and then AUTOL to start the AUTomatic Line numbering:

```
>> SCR  
>> AUTOL 10,10
```

Next, type in your first instruction:

```
>>10 LET N = 5
```

When the program is RUN, this instruction will assign a value of 5 to the variable N. BASIC will remember this value and it will remain the same until redefined by the user or by an algorithm within the program. BASIC will also understand the statement above without the LET, as:

```
>>10 N = 5
```

This is called an implied LET and is a characteristic of advanced versions of BASIC. BASIC will also disregard spacing of characters in statement lines. Thus, the statement:

```
10 LET N = 5
```

is equivalent to the statement:

```
10 LET N=5
```

At this point, we have the following line on the terminal:

```
>>AUTOL 10, 10  
>>10 N = 5
```

BASIC is waiting for our next instruction. Type in:

```
>>20 INPUT A: INPUT B: INPUT C: INPUT D: INPUT E
```

With this long statement line, we have created a set of instructions that will ask for five numbers (inputs A,B,C,D, and E) when the program is run. In 16K BASIC, more than one instruction can be associated with a line number. These instructions

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must be separated by colons. Multi-instruction statement lines save memory space.

Next, we enter the statement:

```
>>30 X = (A+B+C+D+E)/N
```

This assigns the value of the sum of the five INPUT numbers divided by the value of the variable N to variable X. The variable X is therefore the average of these five values. We defined N as 5 previously. If we had not defined N, then it would be assumed that N = 0.

Naturally, we'll want to look at X to see what it is. We type in:

```
>>40 PRINT X
```

which instructs BASIC to print that value of X when the program is run. What do we have so far? Our program, as listed below, looks ready to run.

```
>>AUTOL 10, 10  
>>10 N = 5  
>>20 INPUT A: INPUT B: INPUT C: INPUT D: INPUT E  
>>30 X = (A+B+C+D+E)/N  
>>40 PRINT X
```

16K BASIC does not require an END or STOP, but it is good programming practice to include one. So we can add the following statement to our program:

```
>>50 END
```

If we wanted to run through the program a number of times, finding means for many groups of five numbers, we might have entered:

```
50 GOTO 10
```

This would instruct BASIC to return to line 10 and re-execute the program, finding the mean of five new numbers each time. To escape from such a loop, or from a program during its execution, press the ESCape key on your terminal or teletype keyboard.

Now let's run the program. After statement line 50 is typed in we depress the carriage RETURN in response to the next line number to get out of the

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AUT0matic Line numbering mode. Then we type in:

```
>>RUN
```

This command instructs the computer to begin execution of the program. When the first INPUT command in line 20 is encountered during program execution, a question mark (called a prompt) will appear on your terminal, as indicated below:

```
>>RUN
```

```
?
```

This prompt indicates that the computer is waiting for you to input a number for the first variable in the INPUT statement. We therefore type in:

```
? 17
```

and BASIC responds with:

```
? 17
```

```
?
```

The second prompt indicates that the computer is waiting for a value for INPUT B. In fact, we need to enter values for the next four INPUT variables. Once we input these values and depress the carriage RETURN, the computer will complete program execution and PRINT out the value of X, as shown below:

```
>>RUN
? 17
? 25
? 12
? 18
? 13
17
***50 END***
```

Almost instantly, the BASIC program has calculated and printed the average of the five numbers we input. This average is 17. At this point, we might want to do a little formatting to change the way in which the results are printed out. We LIST the program again to see what we have to work with.

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>>LIST

```
10 N = 5
20 INPUT A: INPUT B: INPUT C: INPUT D: INPUT E
30 X = (A+B+C+D+E)/N
40 PRINT X
50 END
```

We can start by inserting some lines within the present text of the program. At any time, lines can be inserted between present statements by using a number which falls between two line numbers. For example, a line numbered 15 will be inserted between statement number 10 and statement 20. When a program is RUN or LISTed, the new statement lines are automatically inserted into the proper space in the hierarchy.

We decide to add spaces between lines to make reading easier. We add:

```
>>15 PRINT
>>16 PRINT
>>35 PRINT
>>36 PRINT
```

Inserting a PRINT instruction in a statement line without text to be printed generates a linefeed. At this point, you'll want another look at the program. BASIC will have sandwiched the new statement lines into the old text as shown below:

>>LIST

```
10 N = 5
15 PRINT
16 PRINT
20 INPUT A: INPUT B: INPUT C: INPUT D: INPUT E
30 X = (A+B+C+D+E)/N
35 PRINT
36 PRINT
40 PRINT X
50 END
```

Now type RUN. According to our program, the computer will skip two lines after you type in RUN and then wait for you to type in 5 numbers. Once

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these numbers are input, the program instructs the computer to skip two more lines and then PRINT the result. This output appears on the terminal as follows:

```
>>RUN
```

```
? 22  
? 14  
? 16  
? 20  
? 28
```

```
20  
***50 END***
```

Many more variations may be added. For example, the statement:

```
5 PRINT "A PROGRAM TO CALCULATE THE"  
7 PRINT "AVERAGE OF 5 NUMBERS"
```

will give you a title for this program. You might also replace line 40 with:

```
40 PRINT "THE MEAN OF THESE NUMBERS IS ";X
```

If it becomes necessary to enter a line between two others whose line numbers are consecutive (say you need a line between lines 35 and 36), the RENUMBER command can be used to spread the line numbers apart. While a program is in the User Area, type the command:

```
>> RENUMBER  
>>
```

and BASIC will assign new line numbers starting with 10 and incrementing by 10.

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7.3.1 Using the SAVE and LOAD commands

The SAVE command will write the program which is current in the User Area to a disk file. The program will be in internal machine format unlike a program which is written to disk using the LIST command. The LOAD command is to the SAVE command what the ENTER command is to the LIST command. LOAD allows the user to read a SAVED file into the User Area. Notice that LOAD cannot be used with a LISTed file and that ENTER cannot be used with a SAVED file.

The formats of these commands are:

```
>>SAVE "SECOND"  
>>LOAD "SECOND"
```

When used with larger programs, SAVE and LOAD can be significantly faster than LIST and ENTER. Also, when the RUN instruction is given with the name of a SAVED file, the specified file will be LOADED and RUN with only that one instruction. Programs may be chained in this fashion, one calling the next, calling the next, etc.

```
>>RUN "SECOND"
```

or

```
9999 RUN "SECOND"
```

The execution of either of these instructions will cause the SAVED program SECOND to be LOADED into the User Area and execution to begin.

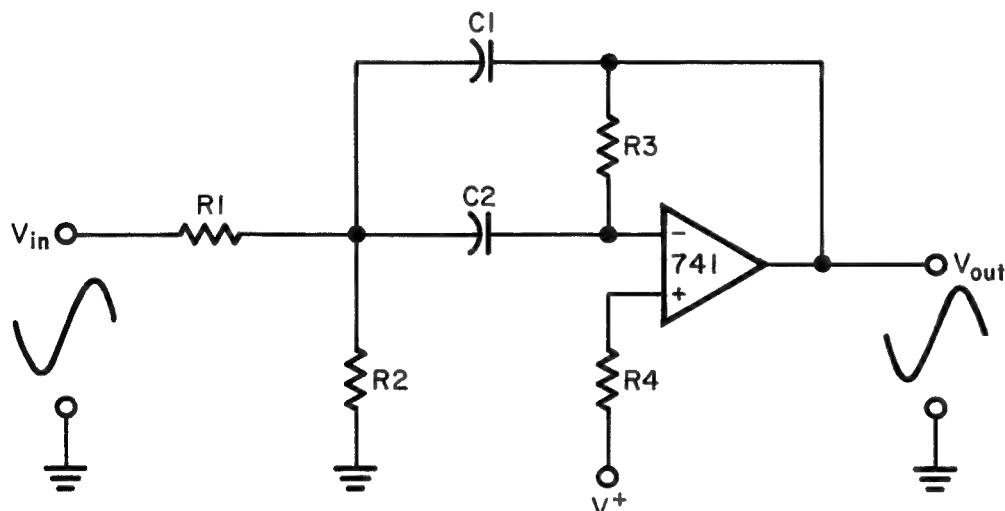
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7.4 Example Program Three

Active Bandpass Filter Calculation

One of the most elementary applications for a computer is to use the computer to do calculations that can be done on sophisticated hand calculators. A program written to perform such calculations can be saved and reused as often as required. An example of a simple calculation program follows. This program allows the user to input data on certain parameters associated with the design of an active bandpass filter based on a common operational amplifier. The program then calculates the necessary component values based on the data.

A BANDPASS 741-TYPE ACTIVE FILTER



NOTE: NO PHASE RELATIONSHIP IMPLIED

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The first three statement lines of the program are as follows. Notice that the at sign (@) is used instead of the word PRINT. When a lot of PRINT instructions are used, this can facilitate program entry.

```
10 @  
20 @"THIS PROGRAM CALCULATES DATA NEEDED TO CONSTRUCT"  
30 @"ACTIVE BANDPASS FILTERS USING 741-TYPE OP-AMPS."
```

The principal function of PRINT statements 20 and 30 is to document the program so that it can be run in the future by users who are unfamiliar with it. All programmers should be encouraged to document programs thoroughly.

The next step in the program is to request the user to input a number of values for various parameters. Note that each variable is defined in preceding PRINT statements.

```
40 @  
50 @"WHAT IS THE CENTER FREQUENCY OF THE PASS BAND,"  
60 @"IN HERTZ (E.G., 4000, 250, 60)";  
80 INPUT F  
90 @  
100 @"WHAT IS THE DESIRED GAIN, IN DECIBELS?"  
110 @"(E.G., 0, 5, 25)";  
130 INPUT H  
140 @  
150 @"WHAT IS THE DESIRED Q OF THE FILTER?";  
170 INPUT Q  
180 @  
190 @"SELECT A CONVENIENT STARTING VALUE C FOR"  
195 @"CAPACITORS C1 AND C2."  
200 @"IF THE VALUE IS IN PICOFARADS, ENTER THE DATA"  
210 @"IN THE FORMAT: X...E-12. IF THE VALUE IS"  
220 @"IN MICROFARADS, USE THE FORMAT: X...E-6."  
240 INPUT C
```

In this schematic formula, C1 and C2 are equal. Once a value for C is specified, the resistor values can easily be found. The next step then is to specify the formulas for each resistor value, as indicated below:

```
250 @ : @ : @  
280 @"RESISTANCE IN OHMS"  
290 @ : @  
310 LET W=F*2*3.14159  
320 @ USING"R1 = #####.###",Q/(H*W*C)
```

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```

330 @ USING"R2 = #####.###",Q/(((2*Q*Q)-H)*(W*C))
340 @ USING"R3 = #####.###", (2*Q)/(W*C)
350 @ USING"R4 = #####.###", 2*((2*Q)/(W*C))

```

These formulas for R1, R2, R3, and R4, specify the calculations which must be performed to determine the various resistances. The final section of the program provides a simple routine which allows the user to easily re-enter the program and input a new set of values.

```

360 @ : @
380 @"WOULD YOU LIKE TO CALCULATE ANOTHER FILTER?"
390 @"TYPE Y FOR YES";
410 INPUT A$
420 @ : @ : @
450 IF A$(0,0)="Y"THEN GOTO 40
460 END

```

If the user does not wish to do another filter calculation and consequently types in a string starting with a character other than Y, then the program ends and BASIC returns to the immediate or command mode.

Note that the variables in this program are given letter symbols that correspond to their function. For example, it is surely easier to remember that the Q of the filter is represented by variable Q than by variable L. Similarly the variable for capacitors C1 and C2 is C, rather than X or Y. These may seem to be intuitively obvious at this level of complexity, but as the program complexity increases the assignment of appropriate variable names becomes much more difficult.

Once the program has been input, we can instruct the computer to execute the program by typing in RUN. The following output will be generated:

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>>RUN

THIS PROGRAM CALCULATES DATA NEEDED TO CONSTRUCT
ACTIVE BANDPASS FILTERS USING 741-TYPE OP-AMPS.

WHAT IS THE CENTER FREQUENCY OF THE PASS BAND,
IN HERTZ (E.G., 4000, 250, 60)? 1000

WHAT IS THE DESIRED GAIN, IN DECIBELS
(E.G., 0, 5, 25)? 20

WHAT IS THE DESIRED Q OF THE FILTER?? 100

SELECT A CONVENIENT STARTING VALUE C FOR
CAPACITORS C1 AND C2.

IF THE VALUE IS IN PICOFARADS, ENTER THE DATA
IN THE FORMAT: X...E-12. IF THE VALUE IS
IN MICROFARADS USE THE FORMAT: X...E-6.
? 1.0E-6

RESISTANCE IN OHMS

R1 = 795.775
R2 = .005
R3 = 31831.016
R4 = 63662.031

WOULD YOU LIKE TO CALCULATE ANOTHER FILTER?
TYPE Y FOR YES? NO

460 END

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7.5 Example Program Four

Statistical Analysis Program

Another common use for a computer is the calculation of statistics for a given set of data, particularly very large data sets. The program listed below calculates six common statistics for a given data set.

One of the first steps that must be taken in any program is the assignment of variable names to any variables which will appear in the program. The following program involves six functions which will require variable names. These functions and the corresponding variable name used in the program to represent each function are listed below:

<u>Variable Name</u>	<u>Function</u>
N	Number of elements in a data set
S	Sum of the numbers in a data set
T	Sum squares
M	Mean
V	Variance
D	Standard Deviation

We instruct the computer to keep track of the number of elements in a data set by including a counter variable in the program. In this case, the counter variable is N. To count the number of elements, we set N equal to 0 initially and then increment N by 1 each time a new element in the data set is READ. Consequently, the first statement lines are used to initialize (set equal to 0) certain variables.

```
10 LET N=0
20 LET S=0
30 LET T=0
```

Note that S and T are also set equal to 0. This will allow us to sum data elements and to sum the squares of data elements as the elements are READ. We can now begin reading in data elements.

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```
40 READ X
50 IF X=999 THEN GOTO 100
60 LET N=N+1
70 LET S=S+X
80 LET T=T+(X*X)
90 GOTO 40
100 IF N=0 THEN GOTO 300
```

The value 999 is used as a dummy value to indicate the end of a data set. The program continues to read in data and increment the values of the variables N, S, and T until a 999 is read from a DATA statement. Once a 999 value is read in, program control is transferred to statement line 100.

Statement line 110 through 130 compute the remaining three statistics.

```
110 LET M=S/N
120 LET V=(N*T-S*S)/N/(N-1)
130 LET D=SQR (V)
```

Next we include a set of titles to be printed out with each statistic.

```
140 PRINT
150 PRINT
160 PRINT "NUMBER", "SUM", "SUM SQUARES"
170 PRINT N,S,T
180 PRINT
190 PRINT "MEAN", "VARIANCE", "STANDARD DEVIATION"
200 PRINT M,V,D
210 PRINT
220 PRINT
```

At this point, all the statistics have been calculated for a set of data. Program control is therefore returned to the first statement in the program so that the next set of data can be read.

```
250 GOTO 10
260 DATA 1,2,3,4,5,6,7,8,9,10,999
270 DATA 2.3,2.4,2.5,2.6,2.7,2.8,999
280 DATA 10,15,29,28,12,44,5.5,2.2,999
290 DATA 999
300 END
```

Once this program has been entered, edited, and examined for errors, it can be RUN. The results are as follows:

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>>RUN

NUMBER 10	SUM 55	SUM SQUARES 385
MEAN 5.5	VARIANCE 9.166666666666	STANDARD DEVIATION 3.0276503540975
NUMBER 6	SUM 15.3	SUM SQUARES 39.19
MEAN 2.55	VARIANCE 0.035	STANDARD DEVIATION 0.18708286933869
NUMBER 8	SUM 145.7	SUM SQUARES 4065.09
MEAN 18.2125	VARIANCE 201.64696428571	STANDARD DEVIATION 14.200245219211

300 END

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7.6 Example Program Five

```
10 REM This is a program which demonstrates
20 REM the implementation of a Random
30 REM Access File.
40 REM
50 REM The program creates and opens a file, writes
60 REM 51 records sequentially, allows
70 REM the user to repeatedly select any
80 REM of the 51 records at random, and
90 REM then closes and erases the file.
100 REM
110 DIM A$(21)
120 INTEGER I,J
130 CREATE "RANDTEST"
140 OPEN \1,24,"RANDTEST"
150 ON ERROR GOTO 220
160 ON ESC GOTO 320
170 PRINT "Pause, writing file RANDTEST"
180 FOR I=0 TO 50
190 PUT \1\ "This is record number ",I
200 NEXT I
210 PRINT
220 PRINT "Which record would you like to see?"
230 PRINT "Enter record number (0-50) or -1 to stop: ";
240 INPUT I
250 IF I<0 THEN GOTO 320
260 IF I>50 THEN GOTO 210
270 GET \1,I\A$(-1),J
280 PRINT "Contents of record number ";I;" is:"
290 PRINT A$;J
300 PRINT
310 GOTO 230
320 CLOSE
330 ERASE "RANDTEST"
340 PRINT : PRINT : PRINT "File RANDTEST erased"
350 END
```

On line 130, the file RANDTEST is CREATED. If a file does not exist in the directory, it must be CREATED before it can be OPENed for reading or writing. The file is OPENed on line 140 with a record length of 24 bytes which are allocated as follows:

22 bytes for the string, and
2 bytes for an integer

Line 150 ensures that any run time error (such as an invalid user response) will return control to

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the user within the program and will not cause the program to terminate abnormally. Because many programs can be terminated by the use of the ESCape key, statement 160 is included in this program. The program will still be terminated by depressing the ESCape key, but the active file will be closed and deleted before control is returned to the user.

Statements 180 through 200 write out 51 records, each containing (for identification) the record number in addition to a string. Because no record numbers are specified, the records are written sequentially starting with record zero.

The user is then asked for the number of the record to be displayed and on line 270 the record whose number is specified by the variable I is retrieved. Because the records which were written to this file each contained a 22 character string followed by an integer number, they must be read back into variables of the same type and length.

The user is allowed to view as many records as are desired. Entering a negative one (-1) when asked for a record number will cause the file to be CLOSEd and ERASEd and program execution to be terminated.

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INSTRUCTIONS AND FUNCTIONS

The following chapters describe the instruction set of Cromemco's 16K Extended BASIC. Although several of the instructions perform a variety of tasks, an attempt has been made to group the instructions and functions into logical divisions.

Program Development Instructions encompass those instructions which are most frequently used by a programmer while developing or modifying programs. Documentation covers the REMark instruction and Assignment covers the use of the Assignment Operator in the LET and MAT instructions.

The Initialization chapter describes those instructions which set and change the type of numeric representation which is used in a program as well as the DIMension instruction.

Control Structures are the instructions which control the logical flow of a program. This includes conditional and unconditional transfer of control, loops, and program termination.

The Input/Output chapter begins with instructions which may be used to transfer information to and from the console terminal as well as those instructions which are used to read DATA statements from the program itself. A discussion of the theory and use of Data Files precedes the definition of the various 16K BASIC instructions which allow the user to control and access files.

The next chapter covers Arithmetic, Trigonometric, Programmer Defined, and String Functions.

The System and File Status chapter shows the user how to determine and change various system statuses and parameters.

Then Machine Level Instructions which allow the user to interact with Assembly Language subroutines and Fatal and Non-fatal Error Messages are

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discussed.

The final chapters include a Glossary of words which may be unfamiliar to the novice, and an Appendix which describes various aspects of the Language which may be of interest to the advanced user.

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instruction: AUTOMATIC Line numbering

format: AUTOL n,m

where:

n is the starting line number.

m is the line number increment.

The AUTOL command provides automatic statement line numbering so that the user does not have to enter a line number for each line when entering a program.

Note:

1. The automatic generation of line numbers may be terminated by pressing the ESCape or carriage RETURN key when the user is prompted for the next line.

Example:

```
>>AUTOL 100,10

>>100 REM ALL LINE NUMBERS IN THIS
>>110 REM EXAMPLE ARE GENERATED BY BASIC.
>>120 I,=5
      $
ERROR 1 -- SYNTAX
>>120 I=5
>>130 REM NOTICE THAT AFTER A SYNTAX ERROR
>>140 REM AUTOL WILL RE-PROMPT SO THAT
>>150 REM THE ERROR CAN BE CORRECTED.
>>160 PRINT I
>>170 END
>>180 (carriage RETURN)
>>
```

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instruction: BYE

format: [Ln] BYE

where:

Ln is an optional number.

The BYE instruction is used to exit from BASIC and return to CDOS on disk systems or MONITOR on non-disk systems.

Notes:

1. For disk systems, after the BYE command is typed in, the computer will respond with the current disk drive.
2. For non-disk systems, BYE goes to location E008H in the MONITOR.
3. See the Appendix, Areas of User Interest, for information on how to cause BYE to jump to another address.
4. BYE will close all files which are OPEN at the time the instruction is executed.

Example:

>>BYE

B.

In this example, the user has typed the BYE command. The next prompt displayed (B.) indicates that the user is in CDOS and that B is the current drive.

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instruction: DELETE

format: [Ln] DELETE n

[Ln] DELETE n, m

where:

Ln is an optional line number.

n is the statement number of the first or only line to be DELETED.

m is a statement number. If used, it indicates that lines numbered n through m are to be DELETED.

The DELETE instruction is used to remove statement lines from the program currently in the User Area.

Notes:

1. The DELETE instruction must be the last (or only) instruction on a line.
2. The DELETE instruction must have at least one argument.

Example:

>>LIST

```
10 INPUT A,B,C
20 D = A+B+C
30 PRINT A
40 PRINT B
50 PRINT C
60 PRINT D
70 END
```

```
>>DELETE 30,50
>>LIST
```

```
10 INPUT A,B,C
20 D = A+B+C
60 PRINT D
70 END
```

Here the DELETE command removes lines 30 through 50 from the program.

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command: DIRectory

format: DIR

DIR svar

where:

svar is a string variable or a string literal file reference.

The DIR command corresponds to the CDOS DIR command (see the CDOS User's Manual for a full description). The DIR command lists disk files giving size (in K-bytes) and number of extents. If the optional file reference is used, it must be enclosed in quotation marks (string literal) or else must be a valid string variable.

Examples:

DIR will list all files on the current disk.

DIR "A:.*" will list all files on drive A.

DIR "*.SAV" will list all files on the current disk with the extension SAV.

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instruction: ENTER

format: [Ln] ENTER svar

where:

Ln is an optional line number.

svar is a string variable or string literal file reference.

The ENTER instruction is used to ENTER a BASIC program (in ASCII format) from a disk file or other external device into the User Area.

Notes:

1. ENTER will read a LISTed program into the User Area. ENTER will not read a SAVED file.
2. ENTER does not delete statement lines from the program which is currently in the User Area. ENTER does replace lines in the current program with lines from the file being ENTERed if the line numbers are the same.
3. Efficient use of memory following an overlay results if the ENTERed program, to as great an extent as is possible, replaces lines in the current program and does not add new line numbers.
4. The ASCII ESCape character (1BH) or CTRL-Z (1AH) are used as the end of file mark by BASIC. ENTER looks for either of these characters to determine the end of the program.

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instruction: LIST

format: [Ln] LIST

[Ln] LIST n

[Ln] LIST n,m

[Ln] LIST svar

[Ln] LIST svar,n

[Ln] LIST svar,n,m

where:

Ln is an optional line number.

svar is a optional string variable or a string literal file reference denoting the destination of the LISTing. If omitted, the LISTing will go to the console.

n is the line number of the first line to be LISTed. If omitted, the entire program will be LISTed.

m is the line number of the last line to be LISTed. If omitted, the program will be listed through the last line.

The LIST instruction is used to LIST one or more statement lines from the User Area to the console, a disk file, or another file device in ASCII format. The instruction may be used to output an entire program, a block of statement lines within a program, or a single statement line. The formats of LIST which do not use svar will direct the output to the console.

Notes:

1. A program which has been LISTed to a disk can be read back into the User Area using the ENTER instruction. It can not be read back using LOAD or RUN.
2. LISTed files are compatible between different

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versions of Cromemco 16K Extended BASIC as well as different versions and sizes of the Cromemco Disk Operating System (CDOS). SAVED files are not necessarily compatible in this manner.

3. The ASCII ESCape character (1BH) is used as the end of file mark by BASIC. LIST outputs this character at the end of a program which is sent to the disk.

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instruction: LOAD

format: [Ln] LOAD svar

where:

Ln is an optional line number.

svar is a string variable or string literal file reference.

The LOAD instruction is used to LOAD a BASIC program (in internal machine format) from a disk file into the User Area.

Notes:

1. LOAD will read a SAVED program into the User Area. The program must have been SAVED under the version of BASIC and the version and size of the Cromemco Disk Operating System under which BASIC is currently being run.

LISTed files are compatible between different versions of Cromemco 16K Extended BASIC as well as different versions and sizes of CDOS; SAVED files are not.

2. The LOAD instruction resets (clears) all variables, string variables, and matrices.
3. LOAD resets the trigonometric mode to RADians.

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instruction: RENUMBER

format: RENUMBER

RENUMBER m

RENUMBER m,n

RENUMBER m,n,b

RENUMBER m,n,b,e

where:

m is the starting line number in the RENUMBERed program.

n is the line number increment in the RENUMBERed program.

b is the first existing line number to be RENUMBERed.

e is the last existing line number to be RENUMBERed.

The RENUMBER instruction alters the statement numbers in the current program.

Notes:

1. The default value for the RENUMBER instruction is a starting line number (m) of 10 and an increment value (n) of 10.
2. If only the first parameter (m) is specified, the second parameter (n) assumes the same value. In the example below, the command RENUMBER 100 is equivalent to the command RENUMBER 100,100.
3. The RENUMBER instruction alters line numbers imbedded in the entire program in GOTO, GOSUB, and IF-THEN statements to conform to the RENUMBERed statements. This will affect a line which is not RENUMBERed if the line contains a reference to a RENUMBERed line.
4. RENUMBER can not normally be used to re-order or rearrange sections of a program relative to other sections. If line numbers are LISTed

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out of order after the RENUMBER instruction is given, follow the procedure in the following note (5a-d) to rearrange the lines into numeric order.

5. The RENUMBER command will include DELETED statement numbers in the sequence of renumbered statements. If this presents a problem (such as one or more statement numbers being omitted) the following procedure will correct the problem:
 - a) LIST the program (do not SAVE it) to a temporary disk file.
 - b) SCRatch the User Area.
 - c) ENTER the temporary disk file.
 - d) RENUMBER as desired.

Examples:

>>LIST

```
11 INPUT A
24 INPUT B
37 PRINT A*B
50 GOTO 11
63 END
```

>>RENUMBER (default parameters are 10,10)

>>LIST

```
10 INPUT A
20 INPUT B
30 PRINT A*B
40 GOTO 10
50 END
```

>>RENUMBER 100 (if n is not specified, n = m)

>>LIST

```
100 INPUT A
200 INPUT B
300 PRINT A*B
400 GOTO 100
500 END
```

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8. Program Development Instructions

>>RENUMBER 100,10

>>LIST

```
100 INPUT A
110 INPUT B
120 PRINT A*B
130 GOTO 100
140 END
```

>>RENUMBER 1000,150,120

(Begin renumbering
at line 120 in the
current program.)

>>LIST

```
100 INPUT A
110 INPUT B
1000 PRINT A*B
1150 GOTO 100
1300 END
```

>>RENUMBER 1000,1,110,1150

(RENUMBER lines
110 through 1150
in the current
program. The
new line numbers
will start at
1000 and use an
increment of 1.)

>>LIST

```
100 INPUT A
1000 INPUT B
1001 PRINT A*B
1002 GOTO 100
1300 END
```

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8. Program Development Instructions

instruction: RUN

format: [Ln] RUN

[Ln] RUN svar

where:

Ln is an optional line number.

svar is a string variable or string literal file reference.

The RUN instruction instructs the computer to execute a program starting at the lowest numbered line.

If svar is omitted, the program which is current in the User Area is executed.

If svar is included, it must be the name of a SAVED program. This program will be LOADED into the User Area and executed.

Notes:

1. The RUN instruction, if given with a file reference, must reference a program which has been SAVED under the version of BASIC and the version and size of the Cromemco Disk Operating System (CDOS) which is currently being used.
LISTed files are compatible between different versions of Cromemco 16K Extended BASIC as well as different versions and sizes of CDOS; SAVED files are not.
2. The RUN instruction resets or clears all variables, string variables, and matrices.
3. RUN sets the trigonometric mode to RADians.
4. RUN resets ON ERROR and ON ESCAPE instructions to their default modes. This means that runtime non-fatal errors as well as the use of the ESCape key will cause a running program to abort and BASIC to display an error message.
5. RUN sets the variable mode to that which was last specified. The default mode is Long

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8. Program Development Instructions

Floating Point. Refer to the Appendix, Areas of User Interest, if it is necessary to change the default mode.

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8. Program Development Instructions

instruction: SAVE

format: [Ln] SAVE svar

where:

Ln is an optional line number.

svar is a string variable or string literal file reference.

The SAVE instruction is used to SAVE the current program on a disk or other file device in internal machine format.

Note:

1. A program which has been SAVED on a disk file can be read back using the LOAD or RUN instructions. A SAVED program can only be LOADED or RUN with the same version of BASIC and the same version and size of CDOS it was SAVED under.

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8. Program Development Instructions

instruction: SCRatch

format: [Ln] SCRatch

where:

Ln is an optional line number.

The SCRatch instruction deletes the current program from the User Area.

Notes:

1. The programmer should keep in mind that the SCRatch command erases everything in the user work space and that SCRatched programs cannot be recovered.
2. Once the work space has been cleared, the user may input a new program or access a SAVED or LISTed program which has been stored on disk.
3. SCRatch sets the trigonometric mode to RADians.
4. SCRatch resets the variable mode to the default mode, normally the Long Floating Point Mode.
5. SCRatch does not reset the ECHO or ESCape mode.
6. SCRatch closes all open files before performing the actual SCRatch. If any file cannot be closed (because of disk or I/O problems) some other files may be left open and the User Area will not be SCRatched. The other files may be closed via the CLOSE\n\ instruction.

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Example:

>>LIST

```
10 X=4
20 INPUT Y
30 Z=X*2+Y
40 PRINT Z
50 END
```

>>SCR

>>LIST

>>

In the above example, all statement lines are deleted from memory. The user can now input a new program.

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8. Program Development Instructions

instruction: TRACE

format: [Ln] TRACE

where:

Ln is an optional line number.

The TRACE instruction sets the TRACE mode so that the user can follow the execution of a program line by line. When in the TRACE mode BASIC will list the line number of each statement being executed. Statement line numbers are listed in angle brackets.

Example:

>>LIST

```
10 TRACE
20 INPUT X
30 PRINT"THIS IS ";X
40 LET Y=X+1
50 PRINT Y
60 END
```

>>RUN

<20>

? 10

<30>

THIS IS 10

<40>

<50>

11

<60>

60 END

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8. Program Development Instructions

instruction: No TRACE

format: [Ln] NTRACE

where:

Ln is an optional line number.

The NTRACE instruction resets the TRACE mode so that statement numbers are not printed during program execution.

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9. Documentation Instruction

instruction: REM

format: [Ln] REM text

where:

Ln is an optional line number.

text is any string of characters.

The REM instruction is used to insert remarks or comments in a program.

Notes:

1. REM statements included in a BASIC program are ignored when the program is executed but are output exactly as entered when the program is LISTed.
2. REM statements occupy space in the User Area. With some long programs, or those with large lists or matrices, it may be necessary to minimize the use of REM statements in order to accommodate the program.
3. Any grammatical or typing mistakes which are made when inputting a REM statement will not generate an error message and will be output precisely as they appear in the statement line.
4. The programmer is encouraged to use REM statements liberally throughout a program to describe program operation. These remarks can be particularly helpful to any one who wishes to use or modify a program written by another person.
5. Multiple spaces in a REM statement consume no more user area than a single space does.

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10. Assignment Instructions

instruction: LET

format: [Ln] LET var = exp

or

[Ln] var = exp

where:

Ln is an optional line number.

var is a numeric or string variable or a reference to an element of a matrix.

exp is the value to be assigned to var. It may be any expression, variable, constant, function, string variable, or literal.

The LET instruction is used to assign a value to a given numeric variable, string variable, or element of a matrix. The equal sign (=) is called the assignment operator. Refer to section 6.2.

Notes:

1. BASIC is designed to allow the user to assign values to variables without entering LET each time. This capability is called implied LET.
2. When a string variable is used with a LET instruction, the portion of the string which is referenced is set equal to null characters before the source is moved into the string variable. The whole string is referenced if no subscripts follow the string variable, while various substrings may be referenced by the use of subscripts. Refer to section 5.2.3, Referencing String Variables, for a complete discussion of the subject. The LET instruction will not move more characters than can be accepted by the destination string or substring which is being referenced.
3. In BASIC, the equal sign is also used as a relational operator. Refer to section 6.3.
4. String variables, functions, or literals may only be assigned to string variables while any

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
10. Assignment Instructions

expression or function yielding a numeric result may only be assigned to a numeric variable.

5. LET and implied LET instructions execute with equal speed.

Examples:

<u>LET Instructions</u>	<u>Equivalent Implied LET Instructions</u>
LET A = 45	A = 45
LET B = A + 10	B = A + 10
LET A\$ = "16K BASIC"	A\$ = "16K BASIC"
LET X = Y + L	X = Y + L
LET G = Q(10,5)	G = Q(10,5)

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10. Assignment Instructions

instruction: MATrix

format: MAT M = aexp

where:

aexp is an arithmetic expression,
variable, or constant.

The MAT instruction is used to set all elements in a matrix (M) equal to the value of the arithmetic expression (aexp).

Notes:

1. Matrix M must be explicitly dimensioned.
2. This instruction is not in the instruction set of STAND ALONE BASIC.

Example:

>>LIST

```
10 DIM A(4)
20 READ A(1),A(2),A(3),A(4)
30 DATA 20,21,22,23
40 PRINT A(1),A(2),A(3),A(4)
50 MAT A=0
60 PRINT A(1),A(2),A(3),A(4)
70 MAT A=1
80 PRINT A(1),A(2),A(3),A(4)
90 END
```

>>RUN

20	21	22	23
0	0	0	0
1	1	1	1
90 END			

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CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
11. Initialization Instructions

instruction: DEGree

format: [Ln] DEG

where:

Ln is an optional line number.

The DEG instruction sets the trigonometric calculation mode to DEGree.

Note:

1. RUN, SCRatch, and LOAD will automatically reset the trigonometric calculation mode to RADian.

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11. Initialization Instructions

instruction: DIM

format: [Ln] DIM M\$(aexp-1)

[Ln] DIM M(aexp-1)

[Ln] DIM M(aexp-1,aexp-2)

[Ln] DIM M(aexp-1,aexp-2,aexp-3)

where:

Ln is an optional line number.

M is a numeric matrix variable.

M\$ is a string variable.

aexp1-3 are arithmetic expressions, variables or constants.

The DIM instruction is used to define the size of a matrix or a string variable. Cromemco BASIC permits the user to define one, two, or three dimensional matrices.

Notes:

1. A DIMensioned numeric matrix variable can have the same name as any other numeric variable. A DIMensioned string variable must have the name of a string variable. Refer to sections 5.1.1 and 5.2.1.
2. If a matrix or string variable is not specifically dimensioned in a program, the default value of 10 (11 elements, numbered 0 through 10) will be automatically assigned to a singly subscripted matrix or string variable. Doubly and triply subscripted matrices will generate an error message if not explicitly dimensioned.
3. The maximum size of any matrix is only restricted by the amount of available memory. Any single dimension may not exceed 16382.
4. The dimension of a string variable may not exceed 32766.
5. The first element in a matrix is numbered 0 (zero indexing).

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11. Initialization Instructions

instruction: IMODE

format: [Ln] IMODE

where:

Ln is an optional line number.

The IMODE instruction changes the default mode of all variables to the Integer mode.

Notes:

1. This instruction takes effect only after the execution of a RUN instruction after the IMODE instruction has been given. See the following example.
2. Integer variables occupy 2 bytes and must be within the range +32767 to -32768.
3. This instruction will be overridden by the LONG and SHORT instructions.

Example:

```
1 IMODE : X=2.5 : IF X=2.5 THEN RUN
```

This line, appearing as the first line of a program, will ensure that the interpreter is in the integer mode. If the line is encountered while the interpreter is not in the integer mode, the IMODE instruction will be given, X will be set equal to 2.5 (a non integer number), and if X=2.5 (as will be the case if SFMODE or LFMODE are current) the RUN instruction will be executed. Program execution will then begin over again, this time the RUN instruction will be given after the IMODE instruction and the current mode will be integer. When the value 2.5 is assigned to X, X will be an integer variable so that 2.5 will be rounded and X will have the value of 3. Then X=2.5 will be false and control will be transferred to the next line.

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11. Initialization Instructions

instruction: INTEGER

format: [Ln] INTEGER A, B(X),...

where:

Ln is an optional line number.

A is a scalar variable

B is a matrix

X is an optional dimension

The INTEGER instruction is used to declare a given variable as INTEGER.

Notes:

1. DIMensioning may be done via the INTEGER instruction.
2. The INTEGER instruction must appear before the variable is referenced for the first time.
3. Integer variables occupy 2 bytes and must be within the range +32767 to -32768.
4. This instruction overrides the SFMODE and LFMODE instructions.

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11. Initialization Instructions

instruction: LFMODE

format: [Ln] LFMODE

where:

Ln is an optional line number.

The LFMODE instruction is used to set all variables within a program to the Long Floating Point mode.

Notes:

1. This is the standard default mode for all variables and arithmetic operations.
2. This instruction takes effect only after the execution of a RUN instruction after the LFMODE instruction has been given. See the following example.
3. Long Floating Point variables occupy 8 bytes and must be within the range $+9.99E+62$ to $+9.99E-65$. They have an accuracy of 14 digits.
4. This instruction will be overridden by the INTEGER and SHORT instructions.
5. See the Appendix, Areas of User Interest, if it is necessary to change the default mode.

Example:

```
1 LFMODE : X=0.12345678 : IF X<>0.12345678 THEN RUN
```

This line, appearing as the first line of a program, will ensure that the interpreter is in the Long Floating Point mode. If the line is encountered while the interpreter is not in the Long Floating Point mode, the LFMODE instruction will be given, X will be set equal to 0.12345678 (a number which cannot be represented in either Short Floating Point or Integer modes), and if X does not equal 0.12345678 (as will be the case if SFMODE or IMODE are current) the RUN instruction will be executed. Program execution will then begin over again, this time the RUN instruction will be given after the LFMODE instruction and the current mode will be Long Floating Point. When the value

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11. Initialization Instructions

0.12345678 is assigned to X, X will be a Long Floating Point variable with the value of 0.12345678. Then X<>0.12345678 will be false and control will be transferred to the next line.

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11. Initialization Instructions

instruction: LONG

format: [Ln] LONG A, B(X),...

where:

Ln is an optional line number.

A is a scalar variable.

B is a matrix.

X is an optional dimension.

The LONG instruction is used to set a given variable to the Long Floating Point mode.

Notes:

1. DIMensioning may be done via the LONG instruction.
2. The LONG instruction must appear before the variable is referenced for the first time.
3. Long Floating Point variables occupy 8 bytes, have an accuracy of 14 digits, and must be within the range $\pm 9.99E+62$ to $\pm 9.99E-65$.
4. This instruction overrides the IMODE and SFMODE instructions.

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11. Initialization Instructions

instruction: RADian

format: [Ln] RAD

where:

Ln is an optional line number.

The RAD instruction sets the RADian mode for trigonometric calculations.

Note:

1. SCRatch, RUN, and LOAD will automatically reset the trigonometric mode to RADian.

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11. Initialization Instructions

instruction: SFMODE

format: [Ln] SFMODE

where:

Ln is an optional line number.

The SFMODE instruction is used to set all variables within a program to the Short Floating Point mode.

Notes:

1. This instruction takes effect only after the execution of a RUN instruction after the SFMODE instruction has been given. See the following example.
2. Short Floating Point variables occupy 4 bytes, have an accuracy of 6 digits, and must be within the range +9.99E+62 to +9.99E-65.
3. This instruction will be overridden by the LONG and INTEGER instructions.

Example:

1 SFMODE : X=0.90000001 : IF X<>0.9 THEN RUN

This line, appearing as the first line of a program, will ensure that the interpreter is in the Short Floating Point mode. If the line is encountered while the interpreter is not in the Short Floating Point mode, the SFMODE instruction will be given, X will be set equal to 0.90000001 and if X is not equal to 0.9 (as will be the case if IMODE or LFMODE are current) the RUN instruction will be executed. Program execution will then begin over again, this time the RUN instruction will have been given after the SFMODE instruction and the current mode will be Short Floating Point. When the value 0.90000001 is assigned to X, X will be a Short Floating Point variable so that 0.90000001 will be rounded and X will have the value of 0.9. Then X<>0.9 will be false and control will be transferred to the next line.

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11. Initialization Instructions

instruction: SHORT

format: [Ln] SHORT A, B(X),...

where:

Ln is an optional line number.

A is a scalar variable.

B is a matrix.

X is an optional dimension.

The SHORT instruction is used to set a given variable to the Short Floating Point mode.

Notes:

1. DIMensioning may be done via the SHORT instruction.
2. The SHORT instruction must appear before the variable is referenced for the first time.
3. Short Floating Point variables occupy 4 bytes, have an accuracy of 6 digits, and must be within the range +9.99+62 to +9.99E-65.
4. This instruction overrides the IMODE and LFMODE instructions.

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12. Control Structure Instructions

command: CONtinue

format: CON

The CONtinue command CONtinues program execution after a program is interrupted by a STOP statement, a program error, or pressing the ESCape key.

Notes:

1. Program execution will commence at the line following the statement at which the program stopped.
2. If program execution stopped because of a program error, the error can be corrected and the CON command used to continue execution from the line following the one where the error occurred.
3. If the user wishes to re-execute the line in error, GOTO (as a command) should be used.

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12. Control Structure Instructions

statement: END

format: Ln END

where:

Ln is a line number.

The END statement halts program execution and causes BASIC to return to the command mode.

Notes:

1. Unlike the STOP statement, program execution may not be CONTinued after an END statement has been executed.
2. Upon execution of the END statement, BASIC displays a message on the console indicating the line number of the END statement which caused the program to halt.

Example:

>>LIST

```
100 PRINT "Tomorrow and tomorrow and tomorrow..."  
200 END
```

>>RUN

```
Tomorrow and tomorrow and tomorrow...  
***200 END***
```

>>

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12. Control Structure Instructions

instruction: FOR...NEXT

format: [Ln] FOR avar=aexp1 TO aexp2 [STEP aexp3]
•
•
[program instructions]
•
•
[Ln] NEXT avar

where:

Ln are optional line numbers.

avar is a non-subscripted numeric variable. This is the index variable.

aexp1-3 are arithmetic expressions, variables, or constants. They may not be string literals or string variables. These are the FOR...NEXT loop parameters.

aexp-1 is the initial value.

aexp-2 is the final value.

aexp-3 is the step value.

The FOR...NEXT instructions are used to repeat a part of a BASIC program a number of times. During the execution of a FOR...NEXT loop, an index (X) is maintained. When this index becomes equal to (or greater than, or less than) the final value (aexp-3), control is transferred to the instruction following the NEXT instruction.

Notes:

1. The following sequence defines the execution of a FOR...NEXT loop:
 - A. The expressions aexp-1, aexp-2, and aexp-3 are evaluated. If aexp-3 is omitted it is given a value of +1 (if the STEP value is not specified it is assumed to be +1).
 - B. The index variable (avar) is set equal to the initial value (aexp-1).
 - C. The instructions following the FOR and preceding the NEXT are executed.

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- D. The step value is added to the index variable ($avar = avar + aexp-3$).
- E. If the STEP value ($aexp-3$) is positive and the index variable ($avar$) is equal to or greater than the final value ($aexp-2$) then the condition for termination of the FOR...NEXT loop has been met and control is transferred to the instruction following the corresponding NEXT instruction.

If the STEP value ($aexp-3$) is negative and the index variable ($avar$) is equal to or less than the final value ($aexp-2$) then the condition for termination of the FOR...NEXT loop has been met and control is transferred to the instruction following the corresponding NEXT instruction.

Otherwise execution of the loop continues with C above.

- 2. The FOR instruction must be the last instruction on a line. It may not be followed by another instruction on the same line.
- 3. The STEP ($aexp-3$) portion of the FOR instruction is optional. If a STEP value is not specified, BASIC assumes a value of +1 for $aexp-3$.
- 4. BASIC programs will execute significantly faster if the loop parameter variables are declared as type INTEGER.
- 5. FOR-NEXT loops may be nested within a program. It is important to keep in mind, however, that each FOR instruction and its corresponding NEXT instruction must be completely contained within any larger loop.
- 6. Program LISTings have FOR...NEXT loops indented for clarity.

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12. Control Structure Instructions

Examples:

>>LIST

```
10  FOR A = 0 TO 10 STEP 2
20  B = A+1
30  PRINT B;
40  NEXT A
50 END
```

>>RUN

```
1357911***50END***
```

In the above example, upon entering the FOR...NEXT loop defined by lines 10 through 40, the loop parameters are evaluated and set equal to:

```
0 (aexp-1, the initial value)
10 (aexp-2, the final value)
2 (aexp-3, the STEP value)
```

The index variable is then set equal to the initial value (A=0). Execution continues with lines 20 and 30 where the variable A maintains the value assigned to it by the FOR instruction. At line 40 the index variable is tested to see if it is equal to or greater than the final value (is A \geq aexp-2?). In this case 0 is not equal to or greater than 10, so execution continues with line 10. The STEP value is added to the index variable (A = A + aexp-3). This continues until (A \geq aexp-2). Then control is transferred to statement 50.

Correct Nesting Format:

```
10  FOR A = 1 TO 50 STEP 2
20  FOR B = 1 TO 30 STEP 5
30  FOR C = 1 TO 10 STEP 1
    .
    .
    .
100  NEXT C
110  NEXT B
120  NEXT A
```

Illegal nesting occurs when FOR...NEXT loops overlap. The following example will generate a run time error.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
12. Control Structure Instructions

Incorrect Nesting Format

```
10 FOR A = 1 TO 50 STEP 2
20 FOR B = 1 TO 30 STEP 5
30 FOR C = 1 TO 10 STEP 1
.
.
.
100 NEXT B
110 NEXT C
120 NEXT A
```

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12. Control Structure Instructions

instruction: GOSUB...RETURN

format: [Ln] GOSUB n

.

.

n [program instructions]

.

.

[Ln] RETURN

where:

Ln are optional line numbers.

n is the line number of the first statement of the subroutine to which control is transferred.

The GOSUB instruction transfers control to a subroutine.

When, during the execution of the subroutine, a RETURN instruction is executed, control is passed to the instruction following the GOSUB instruction which called the subroutine.

Notes:

1. In BASIC, subroutines may be fully enclosed or nested in other subroutines. Subroutines may be nested up to 16 deep.

When nesting subroutines, remember that the RETURN instruction will take you back to the last GOSUB and start execution of the instruction immediately following. Improperly nested GOSUB...RETURN instructions will generate runtime error messages. A nested subroutine is executed after the GOSUB statement and before the RETURN statement of the subroutine in which it is enclosed.

2. The GOSUB and the RETURN instruction must each be the last instruction on a line. They may not be followed by another instruction on the same line.

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12. Control Structure Instructions

Example:

>>LIST

```
20 GOSUB 50
30 PRINT "PROGRAM OVER"
40 END
50 PRINT "THIS IS A SUBROUTINE"
60 PRINT "WHICH DEMONSTRATES THE"
70 PRINT "GOSUB STATEMENT"
80 PRINT
90 RETURN
```

>>RUN

```
THIS IS A SUBROUTINE
WHICH DEMONSTRATES THE
GOSUB STATEMENT
```

```
PROGRAM OVER
***40 END***
```

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12. Control Structure Instructions

instruction: GOTO

format: [Ln] GOTO n

where:

Ln is an optional line number.

n is the line number of the statement to which control is transferred.

The GOTO instruction unconditionally transfers control to the statement line specified by n.

When used as a statement, GOTO interrupts the normal execution sequence of program statements and transfers control to the specified statement.

When used as a command GOTO will cause execution of a program to start with the specified statement.

Notes:

1. When used with the IF...THEN instruction, the words GOTO are optional:

IF X=0 THEN GOTO 50

or

IF X=0 THEN 50

are equivalent and are both legal instructions.

2. When execution of a program is initiated or continued using a GOTO command, no variable initialization takes place.

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12. Control Structure Instructions

Example:

>>LIST

```
10 INPUT A
20 IF A<0 THEN 200
30 B = SQR(A)
40 PRINT "THE SQUARE ROOT OF ";A;" IS ";B
50 GOTO 210
200 PRINT "THIS YIELDS AN IMAGINARY NUMBER"
210 END
```

>>RUN

? - 2

THIS YIELDS AN IMAGINARY NUMBER

210 END

>>RUN

? 9

THE SQUARE ROOT OF 9 IS 3

210 END

In statement 20 the words GOTO are omitted. This statement causes control to be transferred to statement 200 if the condition (A<0) is true. Statement 50 unconditionally transfers control to statement 210.

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12. Control Structure Instructions

instruction: IF...THEN

format-1: [Ln] IF exp THEN n

format-2: [Ln] IF exp THEN instruction

[Ln] IF exp THEN instruction:instruction:...

where:

Ln is an optional line number.

exp is a relational or arithmetic expression, an arithmetic variable, or a constant.

n is the line number of the statement to which control is transferred.

instruction is any BASIC instruction except FOR, NEXT, END, REM or DATA.

The IF...THEN instruction evaluates exp to false ($=\emptyset$) or true (not equal to \emptyset).

If format-1 is used, control is transferred to the specified statement if exp is evaluated as true, and to the next sequential statement if exp is false.

If format-2 is used, and exp is true, the instructions remaining on the same line are executed before control is transferred to the next sequential statement. If exp is false, control passes to the next sequential statement line.

Notes:

1. In a relational expression, a relational operator ($=$, $<$, $>=$, $<=$, $<>$, or $>$) is used to compare two expressions or values. Refer to sections 6.3 and 6.4 for a discussion of relational and boolean operators.
2. No instruction may follow format-1 of the IF...THEN instruction on the same line.
3. Standard BASIC format must be followed for all instructions used with format-2. This includes the restriction that no instruction

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12. Control Structure Instructions

may follow a FOR, GOTO or GOSUB instruction on the same line.

4. IF...THEN instructions may be nested using format-2. For example:

100 IF A = B THEN IF G\$ = "N" THEN 500

is a legal statement.

Examples:

```
100 INPUT A
110 IF A=0 THEN @"MUST BE NON-ZERO": GOTO 100
120 PRINT A
130 END
```

In this example, the computer outputs a prompt (?) to which the user responds with a number. If the number is non-zero (A=0 is false), control will be passed to line 110, the number will be printed, and execution of the program will terminate. If the number is zero (A=0 is true), the part of line 100 after THEN will be executed, printing out the message and returning control to line 100 which will request another number from the user.

```
100 INPUT "First Name: ", A$
200 IF A$ = "FRED" OR A$ = "Fred" THEN GOTO 400
300 GOTO 100
400 PRINT "So you are FRED!"
500 END
```

This program will continue to prompt the user with "First Name:" until the user responds with either Fred or FRED. The IF...THEN instruction includes a compound relational expression:

A\$ = "FRED" OR A\$ = "Fred"

This expression is evaluated as true (=1) if either FRED (all upper case) OR Fred (Upper case F, lower case red) is entered. This type of checking is very useful in interactive programs where a variety of user responses are to be allowed.

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12. Control Structure Instructions

instructions: ON...GOTO
ON...GOSUB

format: [Ln] ON (aexp) GOTO n1,n2,...,ni
[Ln] ON (aexp) GOSUB n1,n2,...,ni

where:

Ln is an optional line number

aexp is an arithmetic expression, variable, or constant

The ON...GOTO and ON...GOSUB instructions transfer control to any one of several lines in a program based on the value of the expression (aexp) contained in the instruction.

Refer to the GOTO and GOSUB instructions for more information.

Notes:

1. When aexp is evaluated, if it is equal to one, control will be passed to the statement numbered n1; if it is equal to two, control will be passed to the statement numbered n2; if it is equal to i, control will be passed to the statement numbered ni.
2. If aexp evaluates to a non integer number the value of the number will be rounded to the nearest integer for the purpose of these instructions.
3. If aexp is evaluated as less than one or greater than i the instruction will be ignored and control will pass to the next sequential instruction.
4. If n1, n2, or ni is a nonexistant line number, and if control is transferred to that line, a fatal run time error will be generated.
5. No instruction may follow an ON...GOTO or ON...GOSUB instruction on the same line.

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12. Control Structure Instructions

statement: STOP

format: Ln STOP

where:

Ln is a line number.

The STOP statement halts program execution and causes BASIC to return to the command mode.

Notes:

1. After a program has been STOPed by a STOP statement execution may be restarted from the statement line immediately following the line containing the STOP statement by the use of the CONTINUE command.
2. Upon execution of the STOP statement, BASIC displays a message on the console indicating the line number of the STOP statement which caused the program to halt.

Example:

```
>>LIST

10 INPUT A,B,C,D,E,F
20 LET N=A+B/C
30 PRINT A;B;C
40 STOP
50 PRINT D;E;F
60 PRINT N
70 END
```

```
>>RUN
? 1,2,3,4,5,6
123
***40 STOP***
>>CON
456
1.6666666666667
***70 END***
```

In this example, the BASIC returns to command mode after encountering the STOP in statement line 40. The program is then CONTINUED when the user enters the CON command.

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13. Console and DATA Input/Output Instructions

instruction: INPUT (from the console)

format: [Ln] INPUT X1,X2,...Xn

[Ln] INPUT "string", X1,X2,...Xn

where:

Ln is an optional line number.

X1...Xn are numeric or string variables.

string is an optional string literal.
It is a prompt to be displayed
on the console upon encountering
the INPUT instruction.

The INPUT instruction assigns a value, input from the console, to a variable. When the INPUT instruction is executed, a prompt (either a question mark (?) or a string as used above) is output to the console. The user should respond to this prompt by entering a list of data which corresponds to the variable list in the INPUT instruction.

Notes:

1. If the string format of the INPUT instruction is used, the string will replace the question mark as the initial prompt.
2. If the user types in fewer data items than are called for in the variable list, a double question mark will appear on the terminal. This prompt continues to appear until each variable has been assigned a value. See examples.
3. If more data is input than is required, an error message will be generated.
4. The type of data input must be the same as the type of variable listed in the INPUT command. For example, if the INPUT command contains a list of numeric variables, the data input must be numeric data. If an attempt is made to INPUT string data into a numeric variable, an error message will be generated.
5. When a string variable is used with an INPUT

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13. Console and DATA Input/Output Instructions

instruction, the portion of the string which is referenced is set equal to null characters before the source is moved into the string variable. The whole string is referenced if no subscripts follow the string variable, while various substrings may be referenced by the use of subscripts. Refer to section 5.2.3, Referencing String Variables, for a complete discussion of the subject. The INPUT instruction will not move more characters than can be accepted by the destination string (or substring) which is being referenced.

6. If the INPUT list is terminated with a semicolon, the carriage RETURN which the user types after the requested data has been entered will not be echoed. This allows more than one prompt and response sequence to appear on a single line.
7. Refer also to the description of the INPUT instruction in the chapter on Data File I/O.

Examples:

```
>>LIST
 10 INPUT A,B,C,D
 20 PRINT A
 30 INPUT E,F
 40 PRINT B;" ";C;" ";D;" ";E;" ";F
 50 END

>>RUN
? 32,18,20,4
32
? 100,200
18 20 4 100 200
***50 END***
```

In the above example, the proper number of items was INPUT in response to each prompt. Suppose we were to respond to INPUT statement 10 with only three numbers:

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13. Console and DATA Input/Output Instructions

```
>>RUN
? 5,10,15
?? 20
5
? 30,40
10 15 20 30 40
***50 END***
```

BASIC displayed an additional prompt (??) when it did not receive as many items as were in the INPUT list.

In our example, line 10 and line 30 can be replaced with lines which will tell the user specifically what items are needed:

```
>>10 INPUT "Enter four numbers: ",A,B,C,D
>>30 INPUT "The last two numbers? ",E,F
>>RUN
Enter four numbers: 100,200,300,400
100
The last two numbers? 500,600
200 300 400 500 600
***50 END***
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
13. Console and DATA Input/Output Instructions

instruction: PRINT (to the console)

format: [Ln] PRINT

[Ln] PRINT A1,A2,...,An

where:

Ln is an optional line number.

A1-n is a number, string literal enclosed in quotation marks, a numeric variable, a string variable, a numeric expression, or a standard or user defined function.

The PRINT instruction is used to output information to the terminal.

Notes:

1. When used alone, the PRINT instruction will generate a new line (CR, LF).
2. The at sign (@) may be used in place of the word PRINT for brevity.

Example:

```
30 PRINT
40 PRINT "AND IT SAVES SPACE"
```

can also be written as:

```
30 @
40 @ "AND IT SAVES SPACE"
```

This facilitates entry of large, text-oriented programs with many blank lines.

3. The spacing of output can be controlled by using a comma (,) or a semicolon (;) between items in a PRINT instruction list.

Items separated by commas are printed beginning in the leftmost column of each printing field. Using the default value of 20 columns per field, the PRINT statement below:

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13. Console and DATA Input/Output Instructions

10 PRINT 1,2,3,4

will produce output in the following format:

	1	2	3	4
column	0	20	40	60
no.				

See the SET instruction to change the default value of the number of columns per field.

If a semicolon is used between items, the items are printed adjacent to each other (i.e., without spaces between items). For example, the statement:

```
10 PRINT "AL"; "TO"; "GE"; "TH"; "ER"  
>>RUN
```

will produce output in the following format:

ALTOGETHER

Commas and semicolons may be used in a PRINT statement in any combination.

4. If more items are listed in a PRINT statement than can be output on one line, BASIC will generate a linefeed and continue printing on the next line.
5. More complex formatting of printed text is possible with the TAB and SPC functions and the PRINT USING instruction.
6. Refer also to the description of the PRINT instruction in the chapter on Data File I/O.

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13. Console and DATA Input/Output Instructions

Example:

>>LIST

```
10 A=1979
20 REM B=YOUR BIRTHDATE
30 PRINT "THIS IS ";A
40 PRINT
50 PRINT
60 INPUT B
70 C=A-B
80 PRINT "YOU WERE BORN IN ";B
90 PRINT
100 PRINT "YOU ARE "; C;" YEARS OLD THIS YEAR"
110 END
```

>>RUN

THIS IS 1979

? 1952
YOU WERE BORN IN 1952

YOU ARE 27 YEARS OLD THIS YEAR
110 END

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13. Console and DATA Input/Output Instructions

instruction: READ

format: [Ln] READ A1,A2,...,An

where:

Ln is an optional line number.

A1-n are numeric or string variables.

The READ instruction is used to read values from DATA statement(s) and assign these values to the READ instruction variable list.

Notes:

1. The order in which variables appear in the READ instruction determines which value from the DATA list will be assigned to which variable. For instance, the first value that appears in the DATA list is assigned to the first variable in the READ list, the fifth value is assigned to the fifth variable, and so forth.
2. A pointer is moved in sequence through the list of DATA values as these values are assigned to variables in the READ list. The number of DATA elements must be equal to or greater than the number of variables in the READ list. If there are fewer items remaining in the DATA list than are in the current READ list, an error message will be generated.
3. DATA elements corresponding to numeric variables must be numeric data and elements corresponding to string variables must be string literals.
4. When a string variable is used with a READ instruction, the portion of the string which is referenced is set equal to null characters before the source is moved into the string variable. The whole string is referenced if no subscripts follow the string variable, while various substrings may be referenced by the use of subscripts. Refer to section 5.2.3, Referencing String Variables, for a complete discussion of the subject. The READ instruction will not move more characters than can be accepted by the destination string (or

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13. Console and DATA Input/Output Instructions

substring) which is being referenced.

Example:

>>LIST

```
10 READ A,B,C,D$  
20 PRINT A,B,C,D$  
30 DATA 10,20,30,"END"  
40 END
```

>>RUN

```
10           20           30           END  
***40 END***
```

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instruction: RESTORE

format: [Ln] RESTORE

[Ln] RESTORE n

where:

Ln is an optional line number.

n is a line number in the current program. This must be a line number of or before a DATA statement. If n is not used, the DATA list pointer is positioned before the first DATA list item in the program. If n is included, the DATA list pointer is positioned before the first occurring DATA list item after the specified line number.

The RESTORE instruction resets the DATA list pointer which is associated with the READ instruction. This allows the user to reread or skip over DATA items.

Example:

>>LIST

```
10 READ A,B,C,D
20 READ E,F,G,H
30 RESTORE
40 READ R,S,T,U
50 RESTORE 90
60 READ L,M,N,O
70 DATA 1,2,3,4
80 DATA 5,6,7,8
90 DATA 9,10,11,12
100 PRINT A,B,C,D
110 PRINT E,F,G,H
120 PRINT R,S,T,U
130 PRINT L,M,N,O
```

>>RUN

1	2	3	4
5	6	7	8
1	2	3	4
9	10	11	12

END

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13. Console and DATA Input/Output Instructions

statement: DATA

format: Ln DATA A1, A2,...,An

where:

Ln is a line number.

A1-An are numeric expressions, constants, or string literals.

The DATA statement specifies values for variables appearing in a READ instruction.

Notes:

1. The READ instruction is used to read values from DATA and assign these values to the READ instruction variable list.
2. The RESTORE instruction allows items in the DATA list to be skipped or reread by resetting the DATA list pointer.

Example:

10 DATA 7*3,9+(2*107),"This is DATA",15,75

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14. Output Formatting Instructions

instruction: PRINT USING

format: [Ln] PRINT USING svar, X1, X2,...,Xn

where:

Ln is an optional line number.

svar is a string literal or string variable format definition.

X1-n are any numeric, string or matrix variables, string literals, or constants.

The PRINT USING instruction allows the user to specify a format for printing output.

Notes:

In examples in this section the character b represents a blank character.

1. A format field is bounded on either side by any character which is not one of the special characters (# & * + , \$! - .). As indicated in the general format for the PRINT USING instruction, a format expression may include more than one format field and may also include string literals. If multiple format fields are specified, the values of expressions are assigned to these fields in order. A format expression may also be assigned to a string variable.

Example:

>>LIST

```
10 A=11 : B=333 : C=22
20 DIM D$(20) : D$="### &&&&M&&&" 
30 PRINT USING"##" &&&&M&&&" ,A,B,C
40 @USING D$,A,B,C
50 END
```

```
>>RUN
11 0333M022
11 0333M022
***50 END***
```

Statement 30 in the above example outputs the

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three variables (A, B, and C) with 2 spaces separating the first two and the literal M separating the last two. Any literal which is not one of the PRINT USING special characters may be used to separate format fields. This literal will be printed between the fields if it is a blank or any other character. Statement 40 outputs the same information in the same format using a string variable instead of a string literal in the PRINT USING instruction. Statement 40 also abbreviates PRINT with the symbol @.

2. When a string appears in the PRINT USING argument list, the characters of the string are printed in the positions held by any of the special format field characters. Strings are left justified in the format field. If the number of characters in the string is less than the number of characters in the format field, the extra spaces will be blank filled. If the number of characters in the string is greater than the number of characters in the format field, the extra characters in the string will be truncated.

Examples:

In the instruction:

PRINT USING "****,***.*", "ABCDEF"
the string literal is output in the format:
ABCDEFbbb

In the instruction:

PRINT USING "&&&,&&.&&.&&","ABCDEFGHIJKLM"
the string literal is output in the format:
ABCDEFGHIJ

3. If the number of items in the expression list exceeds the number of specified format fields, the specified format fields will be re-used for the extra items.

Examples:

In the instruction:

PRINT USING "\$\$&&.&&.", A,B,C
the expressions A, B, and C will all be PRINTed with the format field \$\$&&.&&.

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In the instruction:

PRINT USING "\$\$##bb\$\$&.&", A,B,C

the expressions A and C will be formatted using the format field \$\$## and the expression B will be formatted using the format field \$\$&.&.

4. All normal PRINT functions (such as TAB, SPC, semicolon, and comma) are overridden by the PRINT USING instruction. The only exception is the terminating semicolon which still inhibits the generation of a new line.
5. The format expression may include a maximum of 128 characters.
6. If a number being formatted has more digits than allowed for in the format expression, an all asterisk error message will result.

Digit Formatting

These special characters may be used to format digits:

indicates leading blanks
& indicates leading zeroes
* indicates leading asterisks

These symbols are used to right justify digits in a print field. The width of this print field is determined by the number of special characters included in a format field. Any non-digits (such as a minus sign) are eliminated. If the number of special characters in the format field exceeds the number of digits in the expression, the digits will be right justified within the field and preceded by characters corresponding to the special characters used in the format field. In the following examples, the character b is used to represent blank characters (spaces).

Examples:

<u>Value of Expression</u>	<u>Format Field</u>	<u>Output</u>
1	#####	bbbb1
12	#####	bbb12
123	#####	bb123
1234	#####	b1234
12345	#####	12345
123456	#####	*****

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1	&&&&	00001
12	&&&&	00012
123	&&&&	00123
1234	&&&&	01234
12345	&&&&	12345
123456	&&&&	*****
1	*****	*****1
12	*****	***12
123	*****	**123
1234	*****	*1234
12345	*****	12345
123456	*****	*****

Comma (,)

The comma (,) places a comma in the position in which it appears in the format field. If the format specifies that a comma be output in a position in the field which consists of leading blanks, zeroes, or asterisks, then a blank, a zero, or an asterisk respectively are printed in the comma position.

Examples:

<u>Value of Expression</u>	<u>Format Field</u>	<u>Output</u>
2003	##,###	b2,003
4	##,###	bbbb4
4457	&&,&&	044,57
18	&&,&&	000018
996546	*****,*	99654,6
22	*****,*	****2,2

Decimal Point (.)

The decimal point (.) places a decimal point in the position in which it appears in the format field. All digit positions which follow the decimal point are filled with digits. If the expression contains fewer fractional digits than are specified, zeroes will be printed in the extra positions. If the expression contains more fractional digits than are specified, the expression will be rounded so that the number of fractional digits equals the number of format

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14. Output Formatting Instructions

positions available.

Examples:

<u>Value of Expression</u>	<u>Format Field</u>	<u>Output</u>
234	###.###	234.000
23.4567	###.###	b23.457
13	&&.&	13.0
66.72319	&&.&	66.7
876.1245	*****.*	**876.12
1234567.245	*****.*	*****

In the last example, when too many significant digits appear to the left of a decimal point, an all asterisk error message results.

Fixed Plus (+) and Minus (-) Signs

The plus (+) and minus (-) signs may appear in the first character position in a format field. The character + or - will print the respective sign of an expression in the specified character position in the format field. When an expression is preceded by a plus or minus sign, any leading zeroes will be replaced by blanks, zeroes, or asterisks as specified. When a positive expression is preceded by a minus sign, a blank space is left in the sign position.

Examples:

<u>Value of Expression</u>	<u>Format Field</u>	<u>Output</u>
56.8888	+##.###	+56.889
4.564	+##.###	+b4.564
6.456	+&&&.&&	+006.46
234.2	+&&&.&&	+234.20
-23.56	-*****.*	-***23.6
2345	-*****.*	*2345.0
-2345678.34	-*****.*	*****

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14. Output Formatting Instructions

Floating Plus (++) or Minus (--) Signs

The use of two or more plus or minus signs at the beginning of a format field will output the respective sign directly preceding the value of the expression. If a positive expression is PRINTed USING a floating minus format, a blank is printed immediately preceding the number instead of a minus sign. The additional signs in the floating point format can be used to represent digits.

Examples:

<u>Value of Expression</u>	<u>Format Field</u>	<u>Output</u>
2.234	++##.##	b+b2.234
22.234	++##.##	b+22.234
-44.56	--&&.&	b-044.6
5.32	--&&.&	bb005.3
178.456	++++*.**	b+*178.46
12345678.45	++++*.**	*****
55.17	++++.++	bb+55.17
55.17	-----.--	bbb55.17
-55.17	-----.--	bb-55.17

Fixed Dollar Sign (\$)

The dollar sign (\$) is used in either the first or second character position in the format field to print out a dollar sign in that position. A dollar sign specified in the second position of the format field must be preceded by either a plus (+) or a minus (-) sign.

Examples:

<u>Value of Expression</u>	<u>Format Field</u>	<u>Output</u>
23.456	\$##.##	\$23.46
4.52	\$##.##	\$b4.52
-57.654	-\$&&.&&&	-\$057.654
123.7789	-\$&&.&&&	b\$123.779
2.34	\$*.*	\$2.3
234.55	\$*.*	***

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14. Output Formatting Instructions

Floating Dollar Sign (\$\$)

The use of two or more dollar signs beginning at either the first or second character position in the format field will output a dollar sign immediately preceding the value of an expression. If two or more dollar signs begin in the second character position, the first character position must contain a plus or a minus sign.

Examples:

<u>Value of Expression</u>	<u>Format Field</u>	<u>Output</u>
234.2345	\$\$\$\$#.###	b\$234.235
4.45	\$\$\$\$#.###	bbb\$4.450
23.989	\$\$&.&&	b\$23.99
4.5	\$\$&.&&	b\$04.50
24.56	-\$***.**	bb\$*24.56
-4455.67	-\$***.**	-\$4455.67

Exponent Fields (!!!!)

Four consecutive exclamation characters (!!!!) indicate an exponent in the format field. These four exclamation points represent the expression $E+nn$, where n is any digit. When used with a numeric expression, this format field will output the expression in exponential form.

Examples:

<u>Value of Expression</u>	<u>Format Field</u>	<u>Output</u>
23.3456	##.##!!!!	23.35E+00
2000	##.##!!!!	20.00E+02
-.36	-&&.&&!!!!	-360.00E-03

7. Only the characters # or & should be used to the right of a decimal point. The asterisk (*) character follows the same rules as the # character when used to the right of a decimal point.
8. Either the floating dollar (\$\$) character or pluses (++) or minuses (--) may be used within the same formatting statement, but not both

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14. Output Formatting Instructions

types of characters.

9. A non-floating print character cannot be placed left of a floating character. For example, the format fields \$++ or +\$\$ are legal but the format field +\$++ is illegal.
10. 16K BASIC does not check comma syntax.
11. Only one decimal point may be used in a format field.
12. Trailing + or - signs are illegal.

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14. Output Formatting Instructions

A typical application for the PRINT USING format follows. This application is a program for computing a payroll on an automated basis.

```
10 PRINT "ENTER SOCIAL SECURITY NUMBER AND HOURS WORKED"
20 PRINT "OF FOUR EMPLOYEES"
30 PRINT
40 INPUT A,A1
50 INPUT B,B1
60 INPUT C,C1
70 INPUT D,D1
90 PRINT "WHAT IS THE HOURLY WAGE";
100 INPUT W
110 PRINT
120 PRINT
130 A1=A1*W : B1=B1*W : C1=C1*W : D1=D1*W
140 PRINT USING " #####",A,B,C,D
150 PRINT
160 PRINT USING " $$$#.##",A1,B1,C1,D1
170 PRINT
180 PRINT "ANOTHER FOUR? TYPE 1 IF YES, TYPE 0 IF NO"
190 INPUT Q
200 IF Q=1 THEN GOTO 10
210 END
```

```
>>RUN
ENTER SOCIAL SECURITY NUMBER AND HOURS WORKED
OF FOUR EMPLOYEES
```

```
? 552966937,40
? 525449121,40
? 455238541,35
? 211329494,32
WHAT IS THE HOURLY WAGE? 4.00
```

```
552966937 525449121 455238541 211329494
```

```
$160.00 $160.00 $140.00 $128.00
```

```
ANOTHER FOUR? TYPE 1 IF YES, TYPE 0 IF NO
? 0
***210 END***
```

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14. Output Formatting Instructions

function: SPaCe

format: SPC (aexp)

where:

aexp is an arithmetic expression, variable, or constant.

The SPC function instructs BASIC to PRINT the specified number of spaces.

Notes:

1. The SPC function may be used only with a PRINT instruction. When used elsewhere it is a transparent function. For example:

A = SPC (5.4)

is exactly equivalent to:

A = 5.4

2. Unlike the TAB function, which always determines print position relative to column 0, the SPC function determines print position relative to the current column location.

Example:

>>LIST

```
10 A=2
20 INPUT C,D
30 PRINT SPC(10);A;SPC(A*10);C;D
40 END
```

>>RUN

? 20,30

2

2030

column no. 10

31

In this example, the computer is instructed to skip 10 spaces, print A, skip 20 spaces, and print C and D.

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14. Output Formatting Instructions

function: TAB

format: TAB (aexp)

where:

aexp is an arithmetic expression, variable, or constant.

The TAB function causes output to begin in a specified column.

Notes:

1. The TAB function may be used only with a PRINT instruction. When used elsewhere it is a transparent function. For example:

A = tab (7.3)

is exactly equivalent to

A = 7.3

2. Multiple TAB functions may be included in one PRINT instruction, but the user should keep in mind that the print position indicated by successive TAB functions is always determined relative to column 0.
3. Columns are numbered 0 through the page width so the first column is column 0.
4. If the argument to the TAB function exceeds the current page width, it is reduced modulo that page width to a number between 0 and the page width. The default value for the page width is 79.
5. If the argument is negative, no tabbing takes place.
6. If the (reduced) argument is greater than the current column position, a new line (CR,LF) is issued and the TAB is executed on the next line.

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14. Output Formatting Instructions

Example:

```
>>LIST
10 A=1
20 INPUT B,C,D
30 PRINT TAB(2);B;TAB(5);B+C+D;TAB(A+9);D
40 END

>>RUN
? 5,8,9
5 22 9
***40 END***
```

In this example, the computer is instructed to begin printing B in column 2, to begin printing B+C+D in column 5, and to begin printing D in column 10.

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15. Discussion - Data File Input/Output

DATA FILE INPUT/OUTPUT

15.1 Data Files

Data is information. A file is a place and method for storing many individual items of information.

A computer data file (or file) is defined by:

1. The storage medium (paper tape, floppy disk, etc.),
2. The method of accessing the data (sequential or random),
3. The code by which the data is translated for storage (ASCII or internal machine representation).

15.1.1 Records

A record is a group of related items. A data file is made up of records. Information is inserted into or retrieved from the file record by record.

If a file contained information on all of the baseball games in one year, each record might contain information on one game, one player, or one team. All of the records would contain similar information. If the first record (record number 0) held the statistics on game #1, the first number in the first record could be the number of hits team A got, while the second number would be the number of hits team B got. The third number could be the number of errors made by team A, while the fourth number would be the number of errors made by team B. The second record (record number 1) would contain similar information covering game #2.

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15.1.2 Fields

A field describes one item in a record. A field can contain string (alphabetic) or numeric information.

In the above example, instead of saying that the first number was the number of hits team A got, we could say that the first field was numeric and contained the number of hits team A got. We can now further describe the record layout by saying that the fifth and sixth fields are alphabetic and contain the team names.

15.2 Floppy Diskette

A floppy diskette (or disk) is a flat, round magnetic storage medium. It is protected by a square envelope which exposes only a small portion of the surface of the disk in addition to the hole in the middle. When used in conjunction with a disk drive and disk controller, the disk becomes a data file storage device. Data can be added to the data already on the disk or records on the disk can be changed or deleted.

15.3 Creating a Data File

Before the Cromemco Disk Operating System (CDOS - the operating system through which all disk operations are performed, even if the programmer is using BASIC) can OPEN a disk file, it must CREATE the file in the file directory.

A file can be created from the CDOS monitor by using the CDOS TEXT EDITOR or SCREEN EDITOR. A file can also be created from BASIC by using the CREATE instruction.

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15.3.1 OPENing an I/O Channel

Once a file has been CREATED, it must be OPENed to allow BASIC access to the file. The OPEN instruction reserves an input/output channel and assigns the I/O channel number to the file reference or file device. Once a file has been opened (and assigned a channel number) all input and output from/to that file will be done through the assigned channel.

BASIC normally carries 4 I/O channels in addition to the console. One I/O channel is needed for each file which is OPENed at the same time. Each channel occupies 192 bytes of memory. Increasing the number of channels allows more files to be opened simultaneously but reduces the amount of memory available to the BASIC user. Conversely, decreasing the number of I/O channels increases the amount of available memory. If you wish to change the number of channels available for use, see the Appendix, Changing the Number of I/O Channels.

15.3.2 CLOSE

The CLOSE instruction will disassociate the input/output channel number and the file which were associated by the OPEN instruction. The channel will then be available for use by other files.

15.4 Internal Machine vs. ASCII Representation

BASIC can store data in two formats. Both consist of groups of ones and zeros (binary representation), but each needs to be translated differently for output to a terminal or printer.

ASCII (American Standard Code for Information Interchange) is the closest to written letters and numbers. ASCII is stored in the machine according to the table of ASCII codes (see Appendix B). Each character code occupies one byte (8 bits). When the code is translated from binary to decimal, the character which is represented can be found in the ASCII table. This is the way all BASIC strings are stored. ASCII information is stored so that one character is stored in one byte.

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The need arises for another method of storing numbers when speed of arithmetic computation and amount of storage space become important factors.

Internal Machine code is used only for the storage of numbers. The number of bytes occupied by a number depend on its magnitude and precision (the size of the number and the number of decimal places which need to be kept). There are three internal machine formats:

Integer	size: 2 bytes range: +32767 < N < -32768 accuracy: nearest integer
Short Floating Point	size: 4 bytes range: +9.99E+62 < N < +9.99E-65 accuracy: 6 decimal digits
Long Floating Point	size: 8 bytes range: +9.99E+62 < N < +9.99E-65 accuracy: 14 decimal digits

Refer to Chapter 3 for a more complete discussion of internal machine representation.

15.5 PRINT and INPUT

PRINT and INPUT write and read in ASCII format. These instructions are primarily intended to write data to an output file which is to be printed or typed at a later time, and to read a data file which was created by the editor or another system. When used with a file, they exactly parallel their operation with the console terminal. In particular, file INPUT requires a comma or carriage RETURN between INPUT data items.

IT IS RECOMMENDED THAT THE PUT AND GET INSTRUCTIONS BE USED WITH DATA FILES WHICH ARE TO BE ACCESSED BY BASIC PROGRAMS.

The PRINT and INPUT instructions translate numeric data from ASCII to Internal Machine Format (or vice versa). They are therefore slower than the PUT and GET instructions. There is little need for the programmer to keep track of the type of variable which is written out with a PRINT instruction. An integer variable which is written using the PRINT

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instruction may be INPUT back into a string or floating point variable without losing its meaning. No attempt should be made to INPUT an ASCII string into a numeric variable. A file which has been output using the PRINT instruction may also be TYPED out and read whereas the same file output with the PUT instruction would not be able to be TYPED.

15.6 PUT and GET

The PUT and GET instructions write and read in internal machine format. If an integer variable is written out to a file using a PUT instruction, it must be read back into an integer variable (and not into a floating point variable or an ASCII string) using a GET instruction or it will be meaningless. The machine does no translation with these instructions so they can be executed faster than PRINT and INPUT. The programmer must keep track of the types and lengths of variables written by PUT so that they may be read back in properly.

15.7 An Interesting Note

A string (which is stored internally in ASCII code) may be output with a PUT or PRINT instruction with the same general result (except that PRINT outputs a carriage RETURN-line feed sequence where appropriate and tabs, using spaces, when variables are separated by commas). This is because PUT will output a string in internal machine format, which (for a string) is ASCII. The PRINT will not translate the string because it is already in ASCII format.

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15.8 File Pointer

While a file is OPEN, BASIC maintains a pointer which may determine where the next read or write will occur. This pointer can be manipulated by the various file read and write instructions as will be explained in the following paragraphs.

When a file is first OPENed, the File Pointer is positioned just before the first byte of the first record of the file. If the file is a new file (i.e., it contains no data), the beginning of the file and the end of the file coincide, and so the File Pointer also points to the end of file. This is appropriate. If a read is attempted on a new file, an end of file error will be returned because there is no data in the file.

If no record number is specified in a file I/O instruction (sequential I/O), the data list contained in the instruction is written to or read from the file from the current position of the file pointer.

If a record number is specified in a file I/O instruction (random I/O), the File Pointer is moved to a position just before byte zero of the specified record and then the data list contained in the instruction is written to or read from the file from the new position of the File Pointer.

If a byte number is specified in addition to the record number, the File Pointer will be positioned just before the specified byte in the current or specified record before the I/O instruction is executed.

If there is no data list associated with a PUT instruction, the pointer is repositioned as specified above and no input or output takes place.

After the input or output has taken place, the PUT and GET instructions leave the File Pointer just after the byte which was last input or output.

The PRINT and INPUT instruction use the Carriage RETURN or Carriage RETURN-Line Feed sequence as a delimiter.

The PRINT instruction will move the File Pointer to a position just after the last PRINT character. If

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the PRINT line starts with byte zero of the current record and is the same length as the specified record size, the pointer will be positioned just before byte zero of the next logical (sequential) record.

The PRINT instruction will automatically insert a Carriage RETURN/Line Feed sequence if:

1. the data list associated with the PRINT instruction will cause a record to be output which is longer than the page width (refer to the SET instruction), and
2. no one item in the data list is not itself longer than the specified page width.

This can happen when items in a PRINT list are separated by commas or a PRINT instruction is terminated with a comma or semicolon and a subsequent PRINT instruction adds to the already PRINTed line. This rule also applies to the PRINT instruction when used to send output to the console.

A PRINT list containing an item which is longer than the page width will cause a run time error. The default page width is 80 characters. It is possible to change this parameter by using the SET instruction.

15.9 Sequential Files

A sequential file is written in the order of the record numbers. That is, record number zero is written with the first output (PUT or PRINT) instruction, record number one is written next, then record number two, etc. This continues until the file is CLOSED. When the file is OPENed again, the first record which is output will write over record number zero, etc.

When a file is read sequentially, record zero is read first, then record one, etc.

Note that if an entire record is not input or output each time the file is accessed, the File Pointer will remain after the last character which was read or written. Any subsequent file access

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will read or write from that position, not from the beginning of the next record.

15.10 Random Files

A random access file is written in the order specified by the programmer. Each output instruction must specify the number of the record which is to be written. When a file is read randomly, the programmer must specify the record number to be read for each INPUT or GET instruction.

A file which was written to sequentially may be read as a random file. Files which were written to randomly may be read by sequential or random instructions provided that no attempt is made to read a record before it has been written.

A file may be accessed by any combination of sequential and random instructions.

A random instruction, one that specifies a record or record and byte number, will reposition the File Pointer before accessing the file.

A sequential instruction, one that does not specify a record number, will access the disk from the current position of the File Pointer.

15.11 CDOS DUMP Utility

The CDOS DUMP utility program is very useful for determining exactly what is being sent to a file. The user must exit from BASIC in order to use this program. Refer to the CDOS manual, Utility Programs - DUMP, for further information.

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instruction: CREATE

format: [Ln] CREATE file-ref

where:

Ln is an optional line number

file-ref includes the 1 to 8 character file name and optionally a disk drive specifier and file name extension.

The CREATE instruction places the file name (and file name extension) in the directory of the specified disk. A file may only be created once, and must be CREATED before it can be OPENed.

Notes:

1. The disk drive specifier and/or the file name and/or the file name extension may be a string variable or a string literal.
2. The file name and file name extension may include any printable ASCII character except the following:

\$ * ? = / . , : - "space"
3. No space is allocated to a file by the CREATE instruction. All file space under CDOS is dynamically allocated only when and where needed.
4. Error Number 137 (File Already Exists) will result if the file already exists in the directory when the CREATE instruction is given.

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instruction: OPEN

format: [Ln] OPEN\n\ file-ref

[Ln] OPEN\n,n,pl\ file-ref

[Ln] OPEN\n,n,pl,p2\ file-ref

where:

Ln is an optional line number

n is the required file (channel) number.

pl (for a disk file) is the optional record size in bytes which may be assigned any value between 1 and 32,767. The default value is 128 bytes per record (one sector).

p2 (for a disk file) is the optional file access mode specifier:

=1 is read only
=2 is write only
=3 is read and write
(default value)

file-ref includes the 1 to 8 character file name and optionally a disk drive specifier and file name extension.

The OPEN instruction allows a disk file or system device to be linked to a file number (channel) for future reference in connection with file input/output instructions (i.e., PUT, GET, INPUT, PRINT, CLOSE).

Notes:

1. The disk drive specifier and/or the file name and/or the file name extension may be a string variable or a string literal.
2. The file name and file name extension may include any printable ASCII character except the following:

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`$ * ? = / . , : - "space"`

3. The file number must be between 1 and the maximum channel number available. As disk BASIC is shipped, the maximum channel number is 4. See the Appendix for the method of changing the number of channels available.
4. Error number 133 (File Number) will result if an attempt is made to reference a file number greater than the maximum channel number available.
5. The file number 0 (zero) is reserved for the console. It cannot be OPENed by the user. All Input/Output (GET, INPUT, PUT, and PRINT) directed from/to file 0 will use the console.

Caution, if file number 0 is specified by the CLOSE instruction, all currently OPENed files will be CLOSEd.
6. Although files OPENed for read/write access may be used as write only files, slightly faster execution speed may result if the file is OPENed for write only access.
7. If the PRINT instruction is used to write a single item which is longer than the current page width, it will be necessary to increase the page width (using the SET instruction) in order to avoid Error number 6 (PRINT ITEM SIZE). Refer to the discussion section of this chapter for additional information.

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instruction: CLOSE

format: [Ln] CLOSE

[Ln] CLOSE \n\

where:

Ln is an optional line number

n is an optional file (channel) number. The default value is ALL currently OPENed files.

The CLOSE instruction disassociates the channel number and file which were associated by the OPEN instruction.

Note:

If the CLOSE instruction is given either without a file number or with the file number set equal to 0 (zero), all currently OPENed files will be CLOSEd.

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instruction: PRINT

format: [Ln] PRINT

[Ln] PRINT exp-1,...,exp-n

[Ln] PRINT\n\

[Ln] PRINT\n,p1\

[Ln] PRINT\n,p1,p2\

[Ln] PRINT\n\ exp-1,...,exp-n

[Ln] PRINT\n,p1\ exp,...,exp-n

where: [Ln] is an optional line number

n is an optional file number. If no file number is specified, or if the file number is zero, output goes to the console terminal.

p1 (for a disk file) is the optional record number. The default value is sequential access starting with record 0 or the current position of the File Pointer.

p2 (for a disk file) is the optional byte number. The default value is byte 0.

exp1-n is an optional list of numeric or string expressions, numeric or string variables, or string literals. The data list must be separated by either semicolons or commas. If an item is followed by a comma, the item following it will be printed starting in the next tab position; if it is followed by a semicolon no space will be left before printing the next item.

When used without a file reference, the PRINT instruction will cause the data list to be output

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to the console. When used with a file reference, it will cause the data list to be output to an ASCII device (e.g., the line printer) or a disk file in ASCII format.

Notes:

IT IS RECOMMENDED THAT PRINT ONLY BE USED FOR THE OUTPUT OF PRINT OR LIST FILES AND NOT BE USED FOR WRITING DATA FILES WHICH ARE TO BE READ BACK BY A BASIC PROGRAM.

1. The at (@) sign may be used to abbreviate the word PRINT in this instruction.
2. Most of the above forms of the PRINT instruction may incorporate the PRINT USING feature. Refer to PRINT USING for additional information.
3. The PRINT instruction outputs a carriage return-line feed (0D, 0A hex) sequence at the end of the data list. If the file is to be read in using the INPUT instruction, a CR-LF sequence (or just a CR) must follow each item which is output, as it is this character or character sequence which delimits (terminates) each item. In BASIC, there are two ways this can be accomplished:
 - a. Allow only one item per PRINT instruction.
 - b. Insert a CR between each item as follows:

```
100 A$ = CHR$(13)
200 PRINT \1\ "STRING"; A$; N1; A$; Q$
```

Statement 100 assigns the hexadecimal value of the CR to the string variable A\$. Statement 200 PRINTs a string literal, a numeric variable, and a string variable, each separated by the CR.

The above procedure will allow all of the items output by the PRINT instruction to be read by the INPUT instruction which looks for a CR between each item read.

If only numeric data is to be PRINTed and

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INPUT a comma (ASCII 44) may be used as a delimiter between variables within one INPUT list. The last item in the data list must be delimited by a CR.

4. Specifying a negative number for either p1 or p2 will result in the default value being assigned to that parameter.
5. The PRINT instruction, when given without a data list, causes one blank line to be sent to the console or a PRINT file.

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instruction: INPUT

format: [Ln] INPUT var-1,...,var-n

[Ln] INPUT\n\ var-1,...,var-n

[Ln] INPUT\n\,p1\ var-1,...,var-n

where: [Ln] INPUT\n\,p1\,p2\ var-1,...,var-n

Ln is an optional line number

n is an optional file number. If no file number is specified, or if the file number is zero, input is received from the console terminal.

p1 (for a disk file) is the optional record number. The default value is sequential access starting with record 0 or the current position of the File Pointer.

p2 (for a disk file) is the optional byte number. The default value is byte 0.

var1-n is a list of one or more numeric or string variables.

When used without a file reference, the INPUT instruction will cause the data list to be INPUT from the console. When used with a file reference, it will cause the list to be INPUT from an ASCII device (e.g., paper tape reader) or a disk file in ASCII format.

Notes:

1. When a string variable is used with an INPUT instruction, the portion of the string which is referenced is set equal to null characters before the source is moved into the string variable. The whole string is referenced if no subscripts follow the string variable, while various substrings may be referenced by the use of subscripts. Refer to section 5.2.3, Referencing String Variables, for a complete discussion of the subject. The INPUT

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instruction will not move more characters than can be accepted by the destination string or substring which is being referenced.

2. INPUT can accept no more than 132 characters per line.
3. INPUT retrieves only 7 bit ASCII. The GET instruction must be used to retrieve all 8 bits.
4. INPUT treats some control characters as editing or end of file commands.

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instruction: PUT

format: [Ln] PUT\n\

[Ln] PUT\n\ exp-1,...,exp-n

[Ln] PUT\n\,p1\ exp,...,exp-n

[Ln] PUT\n\,p1,p2\ exp-1,...,exp-n

where:

Ln is an optional line number

n is a file number. If file number 0 is used, output will be set to the console.

p1 (for a disk file) is the optional record number. The default value is sequential access starting with record 0 or the current position of the File Pointer.

p2 (for a disk file) is the optional byte number. The default value is byte 0.

exp1-n is an optional list of numeric or string expressions, numeric or string variables, or string literals.

The PUT instruction outPUTs the data in the data list (exp-1,...exp-n) to the file specified by the file number (n). The data is output in internal machine format. This is useful if the data is to be read back by BASIC. The PRINT instruction should be used if the file is to be TYPED or listed to the printer.

Notes:

1. If no output list is included, only the device status is set (i.e., record and byte position on a disk file). This is a useful way of setting status (position) without actually initiating any data transfer.
2. The PUT instruction will output data to a file in internal machine format (see notes at the beginning of this chapter on Internal Machine

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vs. ASCII Representation). Numeric data which has been output using the PUT instruction must be read back in using the GET instruction.

3. ASCII data which is output by the PUT instruction will not be readable by INPUT unless a CR appears at least every 132 bytes.

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instruction: GET

format: [Ln] GET\n\ exp-1,...,exp-n

[Ln] GET\n\,p1\ exp-1,...,exp-n

[Ln] GET\n\,p1,p2\ exp-1,...,exp-n

where:

Ln is an optional line number

n is a file number. If file number 0 is used, input will be accepted from the console.

p1 (for a disk file) is the optional record number. The default value is sequential access starting with record 0 or the current position of the File Pointer.

p2 (for a disk file) is the optional byte number. The default value is byte 0.

exp1-n is an optional list of numeric or string expressions, numeric or string variables, or string literals.

The GET instruction GETs the data in the data list (exp-1,...exp-n) from the file specified by the file number (n). The data is input without translation (internal machine format). This is useful if the data has been output by the PUT instruction.

Note:

1. When a string variable is used with a GET instruction, the portion of the string which is referenced is set equal to null characters before the source is moved into the string variable. The whole string is referenced if no subscripts follow the string variable, while various substrings may be referenced by the use of subscripts. Refer to section 5.2.3, Referencing String Variables, for a complete discussion of the subject. The GET instruction will not move more characters than can be accepted by the destination string or substring which is being referenced.

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16. Functions

PROGRAMMED FUNCTIONS

Cromemco 16K Extended BASIC includes a number of arithmetic and trigonometric functions which perform common, frequently used calculations. These functions are pre-defined in BASIC so that the programmer does not need to write a program everytime one of these functions is required.

Cromemco BASIC also includes a number of functions designed to increase string handling capabilities, a number of system functions which provide general system information, and a function which makes it possible to call assembly language subroutines.

In addition to these pre-defined functions, Cromemco BASIC permits the programmer to define up to 26 additional functions.

Cromemco 16K BASIC includes the following functions:

16.1 Arithmetic Functions

ABS (X)	absolute value of X
BINAND (X,Y)	binary logical AND
BINOR (X,Y)	binary logical OR
BINXOR (X,Y)	binary logical EXCLUSIVE OR
EXP (X)	the value "e" to the power X
FRA (X)	the fractional portion of X
INT (X)	integer value of X
IRN (X)	generates an integer random number between 0 and 32767
LOG (X)	natural logarithm of X

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MAX (X1,..,Xn)	returns the numeric expression Xn with the maximum value in the expression list
MIN (X1,..,Xn)	returns the numeric expression Xn with the minimum value in the expression list
RANDOMIZE	used with RND and IRN to produce different sets of random numbers
RND (X)	generates a random number between 0 and 1
SGN (X)	algebraic sign of X
SQR (X)	square root of X

16.2 Trigonometric Functions

ATN (X)	arctangent of X
COS (X)	cosine of X
SIN (X)	sine of X
TAN (X)	tangent of X

16.3 Programmer Defined Functions

DEF FNs (X1,...,Xn) = Y
allows the user to define up to 26 different functions

16.4 String Functions

ASC (X\$)	provides equivalent ASCII numeric value of the first character of X\$
CHR\$ (X)	gives a single character string which is the ASCII equivalent of X

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LEN (X\$)	returns the length of string X\$.
POS (X\$,Y\$,n)	determines the location of a substring (Y\$) within a string (X\$) by returning the value of the position at which the first character of the substring is located starting with character n.
STR\$ (X)	converts any numeric expression X to a string which is the character representation of X.
VAL (X\$)	converts any string expression X\$ to the numeric representation of X\$.

Descriptions and examples of each of these functions are included in the following section.

Also see Chapters 17 and 18 for descriptions of additional functions.

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16. Arithmetic Functions

function: ABSolute value

format: ABS (aexp)

where:

aexp is an arithmetic expression,
variable, or constant.

The ABS function gives the absolute (i.e.,
positive) value of X, which can be any numeric
expression.

Example:

>>LIST

10 PRINT ABS(-26), ABS(26)
20 END

>>RUN

26

26

20 END

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functions: BINAND

BINOR

BINXOR

format: BINAND(aexp-1,aexp-2)

BINOR(aexp-1,aexp-2)

BINXOR(aexp-1,aexp-2)

where:

aexp1-2 are arithmetic expressions, variables, or constants.

The BINAND, BINOR, BINXOR functions perform logical operations bit by bit on 16-bit operands.

BINAND performs a BINary AND logical operation on aexp-1 and aexp-2. It returns a 1 bit in a given position if both bits are equal to 1 and a 0 otherwise.

BINOR performs a BINary OR logical operation on aexp-1 and aexp-2. It returns a 1 bit in a given position if either bit is equal to 1 and a 0 otherwise.

BINXOR performs a BINary exclusive OR logical operation on aexp-1 and aexp-2. It returns a 1 bit in a given position if either bit is equal to 1 and the other bit is equal to 0. A 0 is returned otherwise.

Notes:

1. If necessary, aexp-1 and/or aexp-2 will be converted to 16 bit integers for the purpose of these functions.
2. Refer to section 6.4 for a discussion of boolean operators.

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function: EXPonent

format: EXP (aexp)

where:

aexp is an arithmetic expression,
variable or constant.

The EXP function calculates the value of the
constant e (where $e = 2.71828\dots$) raised to the
aexpth power.

Example:

>>LIST

```
10 A=4.1
20 B=EXP(A)
30 PRINT B
40 END
```

>>RUN

```
60.340287597344
***40 END***
```

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function: FRActional portion

format: FRA (aexp)

where:

aexp is an arithmetic expression,
variable or constant.

The FRA function returns the fractional portion of
aexp.

Example:

>>LIST

```
10 B=3.7
20 PRINT FRA(B)
30 END
```

>>RUN

```
0.7
***30 END***
```

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function: INTeger portion

format: INT (aexp)

where:

aexp is an arithmetic expression,
variable or constant.

The INT function returns the largest integer value
which is less than or equal to aexp.

Examples:

>>LIST

```
100 A=5.7
200 PRINT INT(A)
300 END
```

>>RUN

5

300 END

>>PRINT INT (-5.7)

-6

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16. Arithmetic Functions

function: Integer Random Number generator

format: IRN (X)

where:

X is a dummy argument.

The IRN function generates an integer random number between 0 and +32767.

Note:

1. To change the sequence of random numbers, the RANDOMIZE instruction should be included in the program.

Example:

>>LIST

```
10 FOR N=1 TO 10
20 PRINT IRN(6)
30 NEXT N
40 END
```

>>RUN

```
29284
25801
18835
4647
9295
18846
4924
10105
20210
7652
***40 END***
```

The program listed above will print out 10 integer random numbers. If this program is run a second time, it will generate the same 10 random numbers. A different set of random numbers will be generated only if a RANDOMIZE statement is included at the beginning of the program.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Arithmetic Functions

function: LOGarithm

format: LOG (aexp)

where:

aexp is an arithmetic expression,
variable or constant.

The LOG function calculates the natural logarithm
(i.e., log to the base e) of aexp.

Note:

1. The logarithm base 10 for aexp can be computed
as follows:

$$\log \text{ base } 10(\text{aexp}) = \text{LOG } (\text{aexp}) / \text{LOG } (10)$$

Example:

>>LIST

```
10 INPUT A
20 B=LOG(A)
30 PRINT B
40 END
```

```
>>RUN
? 3.2
1.1631508098056
***40 END***
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Arithmetic Functions

function: MAXimum value

format: MAX (aexp-1,...,aexp-n)

where:

aexp1-n are arithmetic expressions,
variables, or constants.

The MAX function examines the list of arithmetic expressions (aexp-1 through aexp-n) and returns the value of the largest expression.

Example:

>>LIST

```
10 X=10
20 Y=25
30 M=MAX (X,Y)
40 PRINT M
50 END
```

>>RUN

```
25
***50 END***
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Arithmetic Functions

function: MINimum value

format: MIN (aexp-1,...,aexp-n)

where:

aexp1-n are arithmetic expressions,
variables, or constants.

The MIN function examines the list of arithmetic expressions (aexp-1 through aexp-n) and returns the value of the smallest expression.

Example:

>>LIST

```
10 X=5
20 Y=10
30 M=MIN(X,Y)
40 PRINT M
50 END
```

>>RUN

```
5
***50 END***
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Arithmetic Functions

instruction: RANDOMIZE

format: [Ln] RANDOMIZE

where:

Ln is an optional line number.

The RANDOMIZE instruction is used to reset the random number dummy variable used by the RND and IRN functions so that a different sequence of random numbers will be produced each time the RND and IRN functions are used.

Notes:

1. RANDOMIZE should be used only once within a program utilizing RND to ensure that a truly random sequence of numbers results.
2. RANDOMIZE should be used after generating every 1000 numbers using IRN. This will ensure a truly random sequence of numbers.

Example:

>>LIST

```
10 PRINT "THIS IS A RANDOM NUMBER ";
20 RANDOMIZE
30 PRINT RND (0)
40 END
```

>>RUN

```
THIS IS A RANDOM NUMBER 0.7137712225
***40 END***
```

>>RUN

```
THIS IS A RANDOM NUMBER 0.8171978025
***40 END***
```

This program will print a different random number everytime the program is RUN.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Arithmetic Functions

function: RaNDom number generator

format: RND (X)

where:

X is a dummy argument.

The RND function generates a random number in the range $0 \leq \text{RND}(0) < 1$.

Examples:

>>LIST

```
10 FOR N=1 TO 100
20 PRINT RND(2)
30 NEXT N
40 END
```

The above example will print out 100 random numbers. If this program is run a second time, it will generate the same 100 random numbers. To generate a new set of random numbers each time the program is run, the above example can be rewritten as follows:

>>LIST

```
10 RANDOMIZE
20 FOR N=1 TO 100
30 PRINT RND(2)
40 NEXT N
50 END
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Arithmetic Functions

function: SiGN

format: SGN (aexp)

where:

aexp is an arithmetic expression,
variable or constant.

The SGN function returns a +1 if the value of the expression aexp is greater than 0, a 0 if aexp equals 0, and a -1 if aexp is less than 0.

Example:

>>LIST

```
10 INPUT A,B,C
20 PRINT SGN(A)
30 PRINT SGN(B)
40 PRINT SGN(C)
50 END
```

```
>>RUN
? -12,0,14
-1
0
1
***50 END***
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Arithmetic Functions

function: SQuaRe root

format: SQR (aexp)

where:

aexp is an arithmetic expression,
variable or constant.

The SQR function calculates the square root of any positive expression.

Example:

```
>>PRINT SQR(9)  
3
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Trigonometric Functions

function: ArcTangent

format: ATN (aexp)

where:

aexp is an arithmetic expression,
variable or constant.

The ATN function calculates the arctangent of aexp.

Note:

1. Although 16K BASIC does not include predefined ARCSIN and ARCCOS functions, the user can calculate these using the ATN function as follows:

```
ARCSIN (X) = ATN (X/SQR (-X*X+1))
ARCCOS (X) = -ATN (X/SQR (-X*X+1))+2. *ATN (1.)
```

Example:

```
>>PRINT ATN (.80)
0.67474094222353
```

In this example the arctangent of .80 is equal to .6747094222353 radians. If the DEGree mode is selected, the arctangent of .80 is given in degrees:

```
>>DEG
```

```
>>PRINT ATN (.80)
38.659808254087
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Trigonometric Functions

function: COSine

format: COS (aexp)

where:

aexp is an arithmetic expression,
variable or constant.

The COS function calculates the cosine of the angle
represented by aexp.

Notes:

1. See ATN for a description of how to calculate ARCCOS.
2. Unless DEG mode has been selected, it is assumed that the value of aexp is expressed in RADians.

Example:

>>LIST

```
10 INPUT A
20 LET B=A*2
30 PRINT COS (B)
40 END
```

```
>>RUN
? .60
0.36235775447529
***40 END***
```

In this example, the cosine of a 1.20 radian angle
is .36235775447529.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Trigonometric Functions

function: SINe

format: SIN (aexp)

where:

aexp is an arithmetic expression, variable or constant.

The SIN function calculates the sine of an angle represented by aexp.

Notes:

1. See ATN for a description of how to calculate ARCSIN.
2. It is assumed that the value of aexp is expressed in RADians unless the DEG mode has been specified.

Examples:

>>LIST

```
10 INPUT A
20 PRINT SIN(A*3)
30 END
```

```
>>RUN
? .04
0.11971220728892
***30 END***
```

In this example, the sine of a .12 radian angle is approximately .12.

In the following example, we first select the DEG mode and then request the program to print the sine of a 90 degree angle:

>>LIST

```
5 DEG
10 PRINT SIN(90)
20 END
```

```
>>RUN
1
***20 END***
```

The sine of a 90 degree angle is 1.0.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Trigonometric Functions

function: TANgent

format: TAN (aexp)

where:

aexp is an arithmetic expression,
variable or constant.

The TAN function calculates the tangent of the angle represented by aexp.

Note:

1. It is assumed that the value of aexp is expressed in RADians unless the DEGree mode has been specified.

Example:

>>LIST

```
5 DEG
10 PRINT TAN(30)
20 END
```

>>RUN

```
0.577350269189
***20 END***
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Programmer Defined Functions

function: Programmer Defined

format: DEF FNS(avar-1,avar-2,...,avar-n)=aexp

where:

s is any single ASCII character (A-Z).

avar1-n are arithmetic variables.

aexp is an arithmetic expression, variable, or constant.

The DEF function permits the programmer to define up to 26 functions in addition to the pre-defined functions included in BASIC.

Notes:

1. The definition of a function must be a statement which is encountered during the execution of a program in order for BASIC to retain the definition. After the function has been defined, it may be used in a command line.
2. Any of the variables used in the definition of a function (avar-1 through avar-n) are local to the function. Their use in the definition does not conflict with a variable of the same name appearing elsewhere in the program.

If a variable appears on the right side of the definition without appearing on the left, it is a global variable and maintains its value through a function call.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Programmer Defined Functions

Examples:

>>LIST

```
10 X=20
20 Y=10
30 Z=5
40 DEF FNR (A,B,C)=A*B+C
50 PRINT FNR (X,Y,Z)
60 END
```

>>RUN

```
205
***60 END***
```

In the above example, variables X, Y, and Z are global variables while A, B, and C are local to the definition of the function.

The following example should help to clear up any confusion between local and global variables.

>>LIST

```
100 DEF FNZ (P) = P * D
200 P = 77
300 D = 5
400 E = 10
500 PRINT FNZ (E)
600 PRINT P
700 END
```

>>RUN

```
50
77
***700 END***
```

In the above example, statement 100 defines the function FNZ in terms of the formal parameter (function definition variable) P and the program variable D. In statement 100 P is called a function definition variable because it appears to the left of the equal sign in the function definition. As such, P can not be accessed by the user. The program variable (P) defined by statement 200 is a different variable than the aforementioned function definition variable, and can be accessed by the user. According to the above definitions, D, appearing in statement 100, is a program variable. In statements 300, 400, and 500 program variables P, D, and E are assigned

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. Programmer Defined Functions

values.

In statement 500, the value of the function FNZ is computed using the value of E to replace P in the definition of the function. Being a program variable, D maintains its value in the calculation of the value of the function. Once the value of the function has been calculated, its value is printed.

Statement 600 prints the value of the program variable P to demonstrate that the program variable P can be accessed by the user, that it maintains its value through the function call, and that it is a different variable than the function definition variable P.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. String Functions

function: ASCII value of a character

format: ASC (svar)

where:

svar is a string variable or literal.

The ASC function gives the ASCII decimal value of the first character of any string expression.

Note:

1. See the Appendix for a table of ASCII characters and their values.

Example:

>>LIST

```
10 INPUT X$  
20 PRINT ASC(X$)  
30 END
```

```
>>RUN  
? A  
65  
***30 END***
```

In this example, the ASCII decimal value for the first character of the string variable X\$ (character A) is 65.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. String Functions

function: CHaRacter

format: CHR\$ (aexpr)

where:

aexpr is an arithmetic expression, variable, or constant.

The CHR\$ function returns the single character which is represented in ASCII by aexpr.

Notes:

1. If aexpr is outside of the range $0 \leq aexpr \leq 255$ an error will be generated.
2. This function allows the user to draw graphs or figures with special characters. The function may also be used to initiate special functions such as cursor positioning, generating line or form feeds, or causing a bell to sound on the terminal.
3. This function may be used to output non-printing and special purpose characters such as control or underline characters.
4. CHR\$ may be used any place a string is required.

Example:

```
>>LIST
10 INPUT X
20 PRINT CHR$(X)
30 END

>>RUN
? 42
*
***30 END***
```

The ASCII decimal value 42 is equivalent to the character *. Thus, in the above example, the instruction PRINT CHR\$ (42) instructs the computer to output the character * on the terminal.

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16. String Functions

function: LENGTH of string

format: LEN (svar)

where:

svar is a string variable or literal.

The LEN function returns an integer value which is equal to the number of characters in any string variable X\$. In other words, the LEN function gives the length of a string.

Note:

1. Both characters and spaces are counted as part of the length. Trailing null characters are not counted as part of the string length.

Example:

>>LIST

```
10 DIM X$(20),Y$(30)
20 INPUT X$,Y$
30 @"THERE ARE "; LEN(X$); " CHARACTERS IN X$"
40 @"THERE ARE "; LEN(Y$); " CHARACTERS IN Y$"
50 END
```

>>RUN

? EXAMPLE

?? LENGTH COMMAND

THERE ARE 7 CHARACTERS IN X\$

THERE ARE 14 CHARACTERS IN Y\$

50 END

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. String Functions

function: POSition

format: POS (svar-1,svar-2,,aexp)

where:

svar-1 is a string variable or literal

svar-2 is a substring variable or literal

aexp is an arithmetic expression, variable, or constant

The POS function is used to locate the position within a string (X\$) of the substring (Y\$). The position within the string X\$ at which the search is to begin is specified by the arithmetic expression aexp. This function gives a value equal to the position of the first character of the substring within the string.

Notes:

1. A -1 is returned if the substring is not found.
2. Remember that the first element of a string is numbered 0.

Example:

>>LIST

```
10 DIM X$ (50)
20 X$="THIS IS A SUBSTRING SEARCH"
30 P=POS(X$,"IS",4)
40 R=POS(X$,"R",20)
50 PRINT P
60 PRINT R
70 END
```

>>RUN

5

23

70 END

In this example, the computer is first instructed to search for "IS" starting from the fourth

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. String Functions

character in X\$ and second to search for "R" starting from the twentieth character in X\$. Starting from position 4, the first character in substring "IS" is located in position 5. Starting from position 20, the first character "R" is located in position 23. Consequently, the computer returns a value of 5 for P and 23 for R.

A very useful application of this function is the conversion of numbers from hexadecimal to decimal. The following program demonstrates the principle using a one digit number:

```
>>LIST

1000 DIM A$(0)
1100 INPUT "One digit hex number: ",A$
1200 D = POS ("0123456789ABCDEF", A$, 0)
1300 IF D = -1 THEN GOTO 1100
1400 PRINT "The decimal equivalent is: ";D
1500 GOTO 1100
1600 END
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. String Functions

function: STRing

format: STR\$ (aexp)

where:

aexp is an arithmetic expression, variable, or constant.

The STR\$ function converts aexp to a string which is the ASCII representation of the expression.

Note:

1. Valid input to this function include the decimal point (.) and a leading plus (+) or minus (-) sign.
2. STR\$ may be used anyplace a string is required.

Example:

>>LIST

```
10 INPUT A
20 A$=STR$(A)
30 PRINT A$
40 END
```

```
>>RUN
? 8.45
8.45
***40 END***
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
16. String Functions

function: VALue

format: VAL (svar)

where:

svar is a string variable or literal.

The VAL function converts a string (svar) into a numeric variable which may be used in arithmetic expressions.

Notes:

1. If the argument string for VAL consists of both numeric and non-numeric information, the following conventions hold:

- a. If the first character is non-numeric, VAL will return a zero value (this can be an extremely useful way of decoding a user's input). The first character is considered to be numeric if it is the leading percent sign (%) of a legal hexadecimal constant.
- b. If the first character or characters are numeric they will be converted without consideration of the portion of the string after the first non-numeric character.

Example:

>>LIST

```
10 X$="26.6321"
20 A=1
30 B=A+VAL(X$)
40 PRINT B
50 END
```

```
>>RUN
27.6321
***50 END***
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL

17. System and File Status Instructions & Functions

command: DiSK

format: DSK
DSK "X"

where:

X is a disk drive specifier (1, 2, 3, 4, A, B, C, or D) or the at sign or zero (@ or Ø).

The DSK instruction displays or alters the current system default disk drive.

Notes:

1. When used without a disk drive specifier, DSK displays the current disk drive identifier.

While a program is RUNning, DSK will not display anything. Use IOSTAT (Ø,Ø) to determine the current drive while in the RUN mode.

2. When used with a disk drive specifier, DSK changes the current system default disk drive. The following is a list of equivalent disk drive specifiers:

A: or 1
B: or 2
C: or 3
D: or 4

The above specifiers may be enclosed in quotation marks (string literal) or assigned to a string variable.

New disks are not logged in by changing the default disk drive. See the following note for the method of logging in a new disk from BASIC.

3. When used with the at sign or zero (@ or Ø), DSK logs in a new disk (after it has been inserted in any drive) and causes drive A to become the current system default disk drive. The effect of this is similar to typing CTRL-C while in CDOS.

I = IOSTAT (Ø,Ø): DSK "Ø": DSK CHR\$ (I)
will preserve the current drive while performing a logical CTRL-C (logging in a new disk).

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL

17. System and File Status Instructions & Functions

instruction: ECHO

format: [Ln] ECHO

where:

Ln is an optional line number.

The ECHO instruction is used to re-enable the display of certain information at the console terminal after the display has been disabled by the NOECHO instruction.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL

17. System and File Status Instructions & Functions

instruction: NO ECHO

format: [Ln] NOECHO

where:

Ln is an optional line number.

The NOECHO instruction is used to disable the display of user entered responses to the INPUT instruction.

Notes:

1. This instruction is useful when a secret code or password is to be INPUT. The code will not be displayed on the screen, making theft of the code almost impossible.
2. The NO ECHO mode is NOT reset by the RUN or SCRatch instructions.

Example:

>>LIST

```
100 NOECHO
200 INPUT X
300 PRINT X
400 END
```

>>RUN

```
?          (user entered INPUT is not
            displayed)
517          (the value of X is PRINTed by the
            PRINT statement)
***400 END***
```

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
17. System and File Status Instructions & Functions

instruction: ERASE

format: [Ln] ERASE svar

where:

Ln is an optional line number.

svar is a string literal or string variable file reference.

The ERASE instruction will remove a file from the file directory.

Examples:

```
ERASE "TEMP.BAS"  
ERASE "*.BAK"  
ERASE "B:TEMP.REL"
```

The first of these examples will ERASE the file named TEMP.BAS from the current or default disk drive. The second will ERASE all files from the current disk drive with the file name extension of BAK. The third example will erase the file called TEMP.REL from the disk in the B drive.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL

17. System and File Status Instructions & Functions

instruction: ESCape

format: [Ln] ESC

where:

Ln is an optional line number.

The ESC instruction is used to re-enable ESCape key operation after it has been disabled by the NOESC instruction.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
17. System and File Status Instructions & Functions

instruction: NOESCAPE

format: [Ln] NOESC

where:

Ln is an optional line number.

The NOESCAPE instruction disables the console terminal escape key operation.

Notes:

1. Most terminal keyboards include a key labeled ESC. BASIC recognizes the ESCAPE character as a signal to abort program execution and return to the command mode. The NOESC instruction is used to prevent program interruption when the ESC key is pressed.
2. ESCAPE results from the use of the CTRL-Z, ESC, or CTRL-[key.
3. Most programs will execute significantly faster when the operation of the ESCAPE key has been disabled by the NOESC instruction.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL

17. System and File Status Instructions & Functions

function: FREe space

format: FRE (X)

where:

X is a dummy argument,

The FRE function gives the number of bytes of memory in the User Area which are currently free or unused.

Notes:

1. Certain statements do not occupy their full space until after they have been executed (e.g., DIM).
2. Because BASIC allocates space for its internal tables in segments, the FRE function is only an approximation of the actual number of bytes available to the user.
3. Space recovered from DELETED lines is available for new program lines, not for arrays or variables. Thus, the FRE function will not necessarily reflect available program space.

If statement lines have been DELETED from the User Area, it will be necessary to perform the following procedure in order for the FRE function to reflect the change:

- a) LIST the program (do not SAVE it) to a temporary disk file.
- b) SCRATCH the User Area.
- c) ENTER the temporary disk file.
- d) Type PRINT FRE(X).

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17. System and File Status Instructions & Functions

function: IOSTATUS

format: [Ln] IOSTAT (aexpr-1, aexpr-2)

where:

Ln is an optional line number.

aexpr-1 is a file (channel) number.

aexpr-2 is the status parameter.

The IOSTAT function returns the current status of an opened BASIC file.

<u>Status Parameter</u>	<u>Returned Value</u>	<u>Meaning</u>
0	0	File is ok.
	1	End of File.
	2	Attempt to read an unwritten segment during a random access read.
1	X	X is the current sector number. (This is not the record number.)
2	Y	Y is the current byte number within sector X (above).

Notes:

1. Devices other than disk drives may or may not return status values.
2. IOSTAT(0,0) will return the current disk number. Disk A=1, B=2, C=3, and D=4.
3. If R is the record size of file F, the expression:

$$\text{INT } ((128.0 * \text{IOSTAT } (F,1) + \text{IOSTAT } (F,2)) / R)$$

will give the current record number. A similar expression will yield the current byte within the current record.

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17. System and File Status Instructions & Functions

instruction: ON ERROR

format: [Ln] ON ERROR STOP

[Ln] ON ERROR GOTO nl

[Ln] ON ERROR GOSUB nl

where:

Ln is an optional line number.

nl is the line number of the statement to which control is transferred.

The ON ERROR instruction causes program control to be transferred as specified (STOP, GOTO, or GOSUB) when a non-fatal error occurs during program execution.

Notes:

1. A non-fatal error in BASIC is any error listed in the error table (see Appendix A) with a number of 128 or greater. Errors numbered 127 and below are defined as fatal errors and cannot be trapped with an ON ERROR statement.
2. If ON ERROR is written at the beginning of a program, the instruction specified with ON ERROR will be executed each time a program error occurs. If placed elsewhere in the program, the statement will be executed only for errors which occur during the execution of statements following the execution of the ON ERROR statement.
3. ON ERROR is reset by RUN and SCRATCH instructions.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
17. System and File Status Instructions & Functions

Example:

```
60 INPUT A,B
80 PRINT A*B
100 ON ERROR GOTO 300
120 INPUT C,D
140 PRINT C/D
160 GOTO 60
300 PRINT "A non-fatal error has occurred"
320 GOTO 120
```

In this example, any error which occurs before line 100 has been executed for the first time will be dealt with by the standard system error handling procedure. Any trappable error which occurs after line 100 has been executed will cause program execution to continue with statement line 300.

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17. System and File Status Instructions & Functions

instruction: ON ESCape

format: [Ln] ON ESC STOP

[Ln] ON ESC GOTO nl

[Ln] ON ESC GOSUB nl

where:

Ln is an optional line number.

nl is the line number of the statement to which control is transferred.

The ON ESC instruction causes program control to be transferred as specified (STOP, GOTO, or GOSUB) when the ESCape key is depressed during program execution.

Notes:

1. If ON ESC is written at the beginning of a program, the instruction specified with ON ESC will be executed each time the ESCape key is depressed. If placed elsewhere in the program, the statement will be executed only when the ESCape key is depressed following the execution of the ON ESC statement.
2. ON ESC is reset by RUN and SCRATCH instructions.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL
17. System and File Status Instructions & Functions

Example:

>>LIST

```
10 INPUT A,B,C
15 IF A = -1 THEN 60
20 LET D=A+B+C
30 ON ESC GOTO 10
40 PRINT D
50 GOTO 50
60 END
```

>>RUN

? 10,15,20

45 (escape must be pressed here to
 get out of the loop statement
 50.)

? 70,10,5

85

? -1,0,0

60 END

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL

17. System and File Status Instructions & Functions

instruction: RENAME

format: [Ln] RENAME svar-1, svar-2

where:

Ln is an optional line number.

svar-1 is a string literal or string variable file reference to the existing file.

svar-2 is a string literal or string variable file reference to the new file.

The RENAME instruction is used to give a new file name to a file already in the file directory.

Example:

RENAME "OLDFILE", "NEWFILE"

This command will change the name of the file (on the current disk drive) from OLDFILE to NEWFILE.

CROMEMCO 16K EXTENDED BASIC INSTRUCTION MANUAL

17. System and File Status Instructions & Functions

instruction: SET system parameter

format: SET aexp-1, aexp-2

where:

aexp1-2 are arithmetic expressions, variables, or constants.

aexp-1 is the system parameter number.

aexp-2 is the value to be assigned to the parameter.

The SET instruction is used to change the value of a given system parameter.

Notes:

1. Refer to the SYS instruction for a list of all user accessible system parameters.
2. System parameter number 0 is the width of a page in characters and may assume any value between 0 and 32767. The default value for this parameter is 80 characters which corresponds to a standard 8 1/2 inch page.

A special use of the set command is:

SET 0, -1

which inhibits the automatic carriage RETURN-line feed at the end of a line when page width is reached. Refer to the discussion of the PRINT instruction as it pertains to file output.

Using SET 0,-1 to disable page width checking is especially useful for graphics output to devices such as the Cromemco 3355 printer.

3. System parameter 1 is the tab field width and may assume any value between 1 and 32767. This corresponds to the width of the field which is output by a comma (,) in a PRINT instruction. If the tab field width is set to a 0 or -1, no tabbing takes place (i.e.,

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17. System and File Status Instructions & Functions

commas are treated as semicolons). The default value for this parameter is 20 characters. This default value may be changed, see the Appendix, Areas of User Interest.

4. For disk BASIC only, a System parameter has been added to facilitate timed input. To start the timer, the SET 5 instruction is given, with aexp-2 equal to approximately ten (10) times the number of seconds of delay desired. Halve aexp-2 if using a 2MHz clock. For example:

SET 5,50

will allow about 5 seconds for a complete user response.

When the next INPUT instruction is encountered, BASIC will issue an ERROR 210 -- INPUT TIMEOUT if the user does not respond with a complete input within the allotted time.

Once set, the time used to respond to all subsequent INPUT instructions is added together until it exceeds the specified value, and then an error message is generated. It is therefore necessary to give the SET instruction prior to each timed INPUT. When timed INPUT is no longer desired, it may be de-activated by coding:

SET 5,0

The ON ERROR statement can be used to trap the timeout error. The programmer may find out how much time was used by coding SYS(5) to find the time remaining.

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function: SYSTEM

format: SYS (aexp)

where:

aexp is an arithmetic expression, variable, or constant.

The SYS function provides system information based on the value of the argument aexp.

Notes:

1. See the SET instruction for methods of changing the default values of these system parameters.

<u>Argument</u>	<u>Value</u>	<u>System Parameter Returned</u>
	0	page width (number of characters)
	1	tab field width (number of characters)
	2	character last printed (i.e., current character)
	3	last runtime error number (for disk BASIC) last runtime error two-letter ASCII code (for stand-alone BASIC)
	4	current print column number
	5	current input timer value

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Example:

```
100 ON ERROR GOTO 700
.
.
140 OPEN \1\ "TESTFILE.DAT"
.
.
700 IF SYS(3)=128 THEN CREATE"TESTFILE.DAT": GOTO 140
.
.
```

In this example, if the file TESTFILE.DAT did not originally exist on the disk, the error handler at line 700 would CREATE the file. Lines 710, 720 etc. could be written to test for other values of SYS(3), and take appropriate action(s).

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function: INPut

format: INP (m)

where:

m is an I/O port.

The INP instruction is used to read the contents of INPut port (m).

Note:

1. The value of m must be in the range $0 \leq m \leq 255$.

Example:

```
10 NOESC : INTEGER K
20 IF BINAND(INP(0),%0040%) = 0 THEN GOTO 20
30 K = INP(1)
40 K = BINAND(K,%007F%)
60 IF K = %001B% THEN PRINT : GOTO 100
70 PRINT CHR$(K);
80 IF K = 13 THEN PRINT
90 GOTO 20
100 ESC
110 END
```

When a character is typed at the console, this program will echo it back to the console CRT. A carriage RETURN will be echoed as a carriage RETURN followed by a line feed, and an ESCape will terminate the program.

The NO ESCape instruction at line 10 is necessary to disable BASIC's continuous polling of input port 0. While a program is being executed, basic ignores most characters typed at the console. BASIC continually polls the UART status port 0 and if a character is ready, reads it from port 1. If this character is not an ESCape character, it is ignored by BASIC. If it is an ESCape character, program execution is terminated.

Upon reading the UART status, the status bit is reset. It is necessary to disable BASIC's polling of the status port so that this user program will be able to determine if a character has been typed. If this were not done, BASIC would, by reading the

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status port, reset the character ready bit, thereby preventing the user program from determining that a character had been typed.

Line 60 replaces the ESCape key function by testing the character typed by the user. If it is an ESCape, program execution is terminated.

Statement 20 is a loop which continually polls the UART status ready port to determine if a character has been typed. The Receiver Data Available flag is bit 6 (refer to the 4FDC manual). The contents of input port 0 is ANDed with 40 hex to determine if this bit is a one or a zero. If it is a zero, no data is available, and control remains on line 20, polling the input port again.

If the bit has been set (=1) it indicates that data is available, and statement 30 reads the data from input port 1 and assigns this data to the variable K. Line 40 strips the parity bit off of the input data (the ASCII character set requires only the seven bits, 0 through 6) and as stated before, line 60 terminates program execution upon determining that an ESCape character (1B hex) has been input.

The rest of the program prints the ASCII character whose value was input, outputs a line feed if a carriage RETURN was input, and transfers control to line 20.

When an ESCape is detected, control is transferred to line 100 which re-enables the operation of the ESCape key and terminates program execution.

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instruction: OUTput

format: OUT m, b

where:

m is an I/O port

b is a byte value

The OUT instruction is used to OUTput data byte (b) to OUTput port (m).

Notes:

1. The value of m must be in the range $0 \leq m \leq 255$.
2. The value of b must be in the range $0 \leq b \leq 255$.

Example:

>>OUT 1,75

will display the character K (ASCII 75) on the console terminal (OUTput port 1).

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function: PEEK

format: PEEK (m)

where:

m is a memory location.

The PEEK instruction returns the contents of memory location (m).

Note:

1. If m is decimal, it should be in the range: $0 \leq m \leq 32767$. Hexadecimal numbers may be used to access locations in the range: $0 \leq h \leq \&FFFF\%$.

Example:

PRINT PEEK (5)

will print the contents of memory location 5.

@ PEEK (-2)

is the same as:

@ PEEK (%FFE%)

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instruction: POKE

format: POKE m,b

where:

m is a memory location.

b is a byte value.

The POKE instruction puts the byte value (b) into memory location m.

Notes:

1. If m is decimal, it should be in the range: $0 \leq m \leq 32767$. Hexadecimal numbers may be used to access locations in the range: $0 \leq h \leq \&FFFF\%$.
2. The value of b must be in the range $0 \leq b \leq 255$.

Example:

POKE 1000,255

will place the value 255 into memory location 1000.

POKE 5,-2

is the same as:

POKE 5, %FFFE%

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function: USer program

format: USR (m,P1,...,Pn)

where:

m is the address of the assembly language routine.

P1-n are parameters which are converted to 16 bit integers.

The USR function makes it possible to call an assembly language subroutine from a BASIC program.

Notes:

1. The USR function always requires the user to specify one parameter in addition to the address, even if it is a dummy parameter. For example, USR(0,1) is correct, while USR(0) will result in a syntax error.
2. If m is decimal, it must be in the range: $0 \leq m \leq 32767$. Hexadecimal numbers may be used to access locations in the range: $0 \leq h \leq \&FFFF\%$.
3. USR is a function and must take the form of a function when it is used:

>>100 A = USR (X,Y)

4. When the user routine gains control (at the address specified in the USR function call), the following conventions apply:
 - a) Register A contains the number (n) of parameters in the function call.
 - b) Register pair HL contains the return address to BASIC. The user routine may re-enter BASIC by coding the following assembly language instruction:

JP (HL)

- c) The parameters were placed in order (i.e., P1 was PUSHed first, followed by P2, P3,..., Pn) on the CPU stack and may be recovered via POP instructions.

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d) If and only if n parameters (n is the contents of register A, as above) are POPped off the stack, and the stack pointer is not otherwise changed, BASIC may be re-entered via the following instruction:

RET

e) The routine may return a 16-bit value to be assigned to the function by placing the value in DE register pair before re-entering BASIC.

f) Aside from the restrictions noted above, all registers may be used in any way by the user routine.

Example:

The following routine, when POKEd into position by the BASIC program starting at line 100, will allow the BASIC user to perform CDOS system calls. The USR function must be used to access this routine. The first parameter of the USR function is the starting address of the assembly language routine (in this case, 103 Hex). The second and third parameters are the values which are to be loaded into the DE and BC register pairs before the system call. Upon returning from the routine, the entire USR function takes on the value of the A register. This value may be accessed by assigning the USR function to a variable. Notice that the C portion of the BC register pair always contains the CDOS system call number.

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```
89 REM DATA statements 100 & 110 are the machine
90 REM code equivalent of the following assembly
91 REM language routine:
92 REM
93 REM pop de
94 REM pop bc
95 REM call 5
96 REM ld d,0
97 REM ld e,a
98 REM ret
99 REM
100 DATA %00D1%,%00C1%,%00CD%,%0005%,%0000%
110 DATA %0016%,%0000%,%005F%,%00C9%
120 INTEGER A,I
130 FOR I = %0103% TO %010B%
140 READ A
150 POKE I,A
160 NEXT I
170 REM
1000 REM Following BASIC program demonstrates
1100 REM the CDOS system call which positions the
1200 REM CRT cursor.
1300 REM
1400 SET 0,-1 : REM disable page width checking.
1500 REM clear screen and home cursor.
1600 A = USR(%0103%,0,142)
1700 FOR I = 1 TO 24
1800 GOSUB 4400
1900 NEXT I
2000 REM
2100 REM Clear and home cursor.
2200 A = USR(%0103%,0,142)
2300 FOR I=24 TO 1 STEP -1
2400 GOSUB 4400
2500 NEXT I
2600 GOTO 1600
2700 REM
2800 REM
4000 REM subroutine to compute diagonal column
4100 REM given a row number, position cursor
4200 REM at the given location, and print the
4300 REM index number there.
4400 J = I*3 : REM compute column number
4500 REM Move column number into high byte
4600 REM and row number into low byte
4700 K = 256*J+I
4800 A = USR(%0103%,K,142)
4900 PRINT I;
5000 RETURN
5100 END
```

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[]

Square brackets are used to indicate an optional quantity. The item enclosed in square brackets may be used, in the position indicated, at the user's discretion.

Argument

An argument is an independent variable, constant, or expression used with a BASIC instruction whose value can be specified by the user to instruct BASIC to perform a certain task. For example, in the instruction:

PRINT A, 3, C+7

A, 3, and C+7 are arguments to the BASIC instruction PRINT.

ASCII

This acronym stands for American Standards Code for Information Interchange. It is an industry standard used to assign numerical codes (0 through 127) to 128 characters used as letters, numbers, arithmetic operators, various symbols, and control characters. The ASC(X) function will return the ASCII equivalent of any argument. A table of ASCII codes is provided for reference in the Appendix.

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BASIC Word

A BASIC word, commonly called an instruction, is an alphanumeric set of characters which briefly describes the operation to be performed by the computer. Some examples of BASIC words are:

LIST
PRINT
ON ERR
LEN
STOP
RND

Binary Code

Binary code is defined as a code where every code element is either a 0 or a 1. Computer instructions and data for most microcomputers consist of unique, 8 bit binary codes.

Command

A command in BASIC is an instruction to the computer which specifies an operation to be performed. In contrast to a BASIC statement (see the STATEMENT definition), commands are executed immediately. Commands are used primarily to manipulate or execute a program once the program has been entered. Commands have no line number preceding them.

A powerful feature of Cromemco 16K BASIC is the ability to use most commands as statements. As such, they may be given line numbers and included in the body of the program for execution while the program is running.

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Control Character

A control character is a non-printing ASCII character which is (usually) used to transmit control signals between a peripheral device and the computer. For example, a CTRL-P entered from the console will cause the system printer to echo all information which is displayed on the console.

Current Program

The current program is any program with which the user is currently interacting. When 16K BASIC is entered, no program is current. Should the user enter text to create a new program, this program becomes the current program. If the user calls a saved program from system memory, that program becomes the current program. If the user edits a program, it remains the current program in its edited form.

Data

The term is used in two ways. Strictly speaking, any information contained within memory or control logic is binary data. Whether this data becomes alphanumeric characters or control information depends upon the program in use.

In the other sense, data is used to refer to numerical or string information. In BASIC, this numerical or string information is listed in a file or DATA statement.

Default

With certain BASIC instructions, an argument may be optionally added to control a certain function. If no argument is given, the instruction defaults or reverts to a value already programmed into the BASIC interpreter. For example, the default values of the arguments for the command:

RENUMBER

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are 10,10 in Cromemco BASIC. This default value for RENUMBER will produce automatic line renumbering starting with line 10 and numbering consecutive lines by increments of 10, (e.g., 10, 20, 30, 40...). To change this default value, the BASIC word must be followed by an argument. For example, the command:

RENUMBER 5,5

will provide automatic line renumbering starting with line 5 and continuing by increments of 5 (e.g., 5, 10, 15...).

Disk Storage

A disk is a computer memory device which is used to store information. Disks are typically used in place of main memory when large amounts of information must be stored. A disk is similar in appearance to a phonograph record. Most microcomputer systems currently offer disk storage capabilities through either large or mini floppy disks. The floppy and mini floppy terms refer to the two different sizes (8 inch and 5 inch respectively) of the flexible plastic disks used with the disk assemblies.

Expression

An expression is defined as any combination of variables, constants and operators which is evaluated as a single value or logical condition. For instance, in the statement:

10 LET A = (B*C) + (A*D)

the (B*C) + (A*D) operation, the value of which is assigned to variable A, is interpreted as an expression. In the statement:

10 IF A = B THEN GOTO 250

the logical comparison A = B is called an expression and is evaluated to True (=1) or False (=0).

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File or Data File

A File defines a group of related information. This information is addressed by means of a File Reference and usually resides on a floppy diskette.

File Name

This is a one to eight character label which is used to refer to a File. Several Files may have the same File Name. These Files may be uniquely identified by the use of a Disk Specifier and/or a File Name Extension.

Firmware

Firmware is the middle ground between hardware and software. This term is generally applied to specific software instructions that have been burned in or programmed into Read Only Memory (ROM).

Floating Point Mode

Floating point mode refers to a method of computer calculation in which the computer keeps track of the decimal point in each number. In 16K BASIC, three formats are used to define variables: Integer, Long Floating Point, and Short Floating Point. In the Long Floating Point mode, numerical values are allowed up to 14 digits. In the Short Floating Point mode, numerical values are limited to 6 digits. The default value in Cromemco BASIC is the Long Floating Point (LFP) mode.

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Hardware

In comparison to firmware and software, hardware represents the actual metal (or hard) elements of a computer system. Items such as printers, terminals, and the computer itself are considered to be hardware.

Integer

An integer is defined as a whole number, positive or negative. The following numbers are examples of integers and non-integers:

<u>INTEGERS</u>	<u>NON-INTEGERS</u>
3	3.14159
10	.66666
-5	2/3

Integer Mode

Integer mode is a format used to define variables in which one or all variables within a given program are set to integer values only.

Interactive

An interactive device is one used to achieve direct person to computer communication, and vice versa. The teletype and CRT terminals are the best known examples of interactive terminals, although many variations are possible.

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I/O (Input/Output)

The I/O initials stand for Input and Output. I/O is the transfer of data between the computer system and an external device. Devices such as CRT (Cathode Ray Tube) terminals, TTY (teletypewriter) terminals, and disk drives are examples of devices that accept the input data from the user, another peripheral device, or from the computer memory, and that output data to the computer.

Line Number

All lines in BASIC begin with a line or statement number. For example:

10 PRINT A, B

includes the statement number 10. Line numbers can be assigned manually or through the AUTOL command and may be any integer from 1 through 99999. All BASIC lines have a unique number which is used to access lines which require modification or deletion from the program.

Matrix

A matrix is an array of numeric variables in a prescribed form. For example, the array:

3 2 0
1 4 6
-3 4 5

is a matrix with three rows and three columns. A matrix with m rows and n columns is written:

all a12 a13 ...a1n
a21 a22 a23 ...a2n
.
.
.
aml am2 am3 ...amn

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The individual entries in the matrix are called elements or cells. For example the quantity a_{ij} in the above matrix is the element in row i and column j . Subscripts used to indicate elements always denote the row first and the column second. Cromemco BASIC permits the user to define one, two, or three dimensional matrices. A two (i.e., M_{ij}) or three (i.e., M_{ijk}) dimensional matrix is commonly called a table. A one dimensional matrix, a matrix with n columns but only one row, is commonly called a list. For example, the matrix:

3, -1, 5, -8

is a list (or a matrix) with one row and four columns.

Memory

The computer memory is used to store information, including programs and data, for future use. Microcomputers typically use semiconductor memories, of which the two most common types are random-access memory (RAM) and read-only memory (ROM). From a hardware perspective, memory consists of an array of bistable, individually addressable elements each of which represents a single binary digit. Information can be stored either in main memory, which commonly consists of RAM or ROM, or external storage devices, which include disks, magnetic tape, and magnetic drums.

Peripheral Device

Peripheral devices are units which are used in conjunction with a computer but which are external to the computer. Peripherals refer to devices such as printers, plotters, terminals, disk storage devices, etc., which can be connected to the computer. The computer is assumed to be the central unit and peripherals are merely support devices.

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Program

A computer program is a set of instructions arranged into statement lines. The instructions are used to instruct the computer to perform specified operations in a certain order. Programs are designed and written to solve a wide range of problems and are used in applications as varied as process control, data reduction, telephone systems, mathematical analysis, games, and stock market transactions.

PROM

This acronym stands for Programmable Read Only Memory. PROMs consist of an array of memory cells that can be fixed in certain patterns by the application of higher than normal voltages. These memories are said to be non-volatile; that is, when power is withdrawn the programmed pattern remains.

Recently, EPROMs, or Erasable PROMs, have appeared and have found industry wide usage. EPROMs may be erased by exposure to ultraviolet light, and then re-programmed. The Cromemco Bytesaver II is designed to program EPROMs.

Protocol

Protocol is a set of conventions on the format and content of messages to be exchanged between two logical devices. Most often, differences in timing account for failure of devices to communicate. For example, a certain signal might, of necessity, be present to enable an I/O request to a microprocessor's protocol. To match a computer to a terminal, one must know the mutual handshake protocol.

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RAM

RAM stands for Random Access Memory, or read-write memory. In contrast to PROMs, read-write memory can be changed as well as being read. Some RAMs (known as dynamic) retain data for only a fraction of a second and must be refreshed constantly to retain data. All RAM is volatile and must have power applied to retain data patterns.

ROM

A ROM is a Read Only Memory device that is used for storing fixed information. This information is burned in, or programmed, at specific locations when the ROM is manufactured. A ROM cannot be written into during operation. Any ROM that can later be altered is a Programmable Read Only Memory (see PROM). ROM family memories, once burned, retain their data regardless of power contingencies.

Sector

A Sector is a subdivision of a track. A track on a large disk is divided into 26 sectors while a small disk track is divided into 18 sectors. Sectors are numbered starting from number one and each sector holds one record or 128 (80H) bytes.

Software

Software is a term used to refer to the programs, languages and procedures used in a computer. For example, the 16K BASIC interpreter as well as any BASIC programs are identified as software.

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Statement or Statement Line

A statement in BASIC is an instruction or series of instructions to the computer. A statement is defined as one line in a BASIC program which is preceded by a line number. For example:

100 A = B*C

is defined as a statement. Typically, a statement can contain a maximum of 132 characters.

A powerful feature of Cromemco 16K BASIC is the ability to use most statements as commands. As such, they may be used without line numbers and executed immediately. This is very useful for debugging programs.

Cromemco 16K BASIC also allows more than one instruction on a single statement line as long as adjacent instructions are separated by a colon (:).

String Literal

A string literal (or string) is a sequence of alphanumeric characters, spaces, and special characters. In 16K BASIC, string literals must be enclosed within quotation marks. Examples of valid string literals include:

"CROMEMCO 16K BASIC"
"12345"
"THIS PROGRAM PRINTS SQUARE ROOTS"

The statement:

100 PRINT "CROMEMCO 16K BASIC"

will output the string

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String Variable

A string variable is a variable which may assume the value of a string literal.

Track

A Track is a physically defined circular path which is concentric with the hole in the center of a disk. It is defined by its distance from the center of the disk. With the read/write head of the disk drive located on a given track, data may be read from or written to that track. A large disk has 77 tracks, while a small disk has 40.

User Area

The User Area is the BASIC workspace in which a program can be written, edited, and run. The LIST command displays the contents of the User Area.

Variable

A variable is a quantity that can assume any one of a given set of values. In 16K BASIC, variables are defined by a single letter (A through Z) or a single letter followed by one digit (0 through 9). Examples of legal variable names include:

A

A1

C

C0

Variables represent numeric values. In the statement:

$20 A = 8 + 2$

A is the variable and $8+2$ or 10 is the value assigned to A. A new value can be assigned to A at a subsequent point in the program.

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20. Error Messages

BASIC ERROR MESSAGES

20.1 Fatal Errors

<u>Stand</u>	<u>Alone</u>	<u>BASIC</u>	<u>Error</u>	<u>Disk BASIC</u>	<u>Error</u>	<u>Code</u>	<u>Number</u>	<u>Message</u>	<u>Meaning</u>
						SY	1	Syntax	<p>This error message covers a number of errors which can occur when the user is entering (typing in) a program. For example: Unmatched parentheses: A=(B*(C) Misspelled words: PIRNT A Wrong data type: A\$=3*A Bad punctuation: PRINT A(7;2) Because there is only one message for all these errors, a dollar sign is printed under the line in error at a position approximately indicating the position of the error.</p>
US		2		Using Syntax					<p>The format string for a PRINT USING instruction is in error. For example: PRINT USING "#.##!!!", 3.2E9 (only 3 exclamation marks; 4 required)</p>

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#A	3	Number of Arguments	A function call requires a different number of arguments than the number passed to it. For example: DEF FNA(X,Y)=X+Y PRINT FNA(J)
*	4	No Disk in System	In a stand alone system, a request for a disk-only function was made. e.g., OPEN\1\"LP" (presumably the user meant "\$LP")
IL	5	Illegal Statement	(1) This can be caused by entering a line with a syntax error and then RUNning the program without correcting the line. (2) In certain systems, certain statements can be declared invalid. For example, POKE might be illegal in a time-sharing system.
PS	6	Print Item Size	An attempt was made to print a single item which required more characters than the current page width. e.g., SET 0,10 PRINT "LOTS OF CHARACTERS"
#G	7	Too Many GOSUBs	Subroutines are nested within subroutines to a depth which exceeds that allowed by BASIC.
#(8	EXP Too Complex	Too many levels of expressions, too many parentheses or function references.

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RT	9	Return, No GOSUB Active	The program has no place to return. This can be caused by deleting a line with a GOSUB statement and then encountering its RETURN statement.
NX	10	NEXT Without FOR	FOR and NEXT statements must be paired. This error may occur if a line containing a FOR statement is deleted.
FU	12	Function not Defined	A user function is referenced by the program but has not been defined. If the line containing the DEF FN _S (X) is deleted, the function is no longer defined.
DV	13	DIMension Statement Error	Invalid argument(s) in the DIMension statement. For example: a negative number, DIM A (-20); too many subscripts, DIM B (5,5,5,5); too large an integer, > 16382.
L#	14	GOTO/GOSUB Undefined Line Number	A GOTO or GOSUB statement refers to a line that does not exist.
SS	15	Subscript Values	The values assumed by subscripts must be less than those in the DIMension statement.
#S	16	Number of Subscripts	The number of subscripts associated with a variable must match the number of subscripts in the DIMension statement.
EL	101	End of Statement/End of Line	This is an internal BASIC error - please document and mail to Cromemco, Customer Service Dept.

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SZ 102 Array or String
Space Overflow There is not enough memory
to store the array or
string.

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20.2 User Trappable (Non-Fatal) Errors

<u>Stand Alone BASIC Error Code</u>	<u>Disk BASIC Error Number</u>	<u>Message</u>	<u>Meaning</u>
NF	128	File not Fnd	File not found on disk (file not in directory) or the device name is not in the device directory list.
FN	129	Filename	A disk file name was used in a Stand Alone System or an illegal file name was passed.
CM	130	Invalid Cmd for Device	A command was given to a device which that device was incapable of performing. For example: a read command given to a line printer.
FO	131	File Already Open	An OPEN command was given to a file which was already open.
NO	132	File Not Open	A read or write was attempted using a file which had not been OPENed.
F#	133	File Number	The file number requested was outside the allowable range. The file number must be greater than 0 and less than or equal to the maximum channel number.
OP	134	Cannot Open File	A message from the device driver (or CDOS). (A non-zero value returned on OPEN.)

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FS	135	No File Space	All files in use. The system must have one unused channel to do a LIST, ENTER, SAVE, or LOAD.
*	136	File Mode Error	CDOS only - no more space on disk (or there are 64 directory entries).
*	137	File Already Exists	A READ was attempted from a write only file or vice versa.
*	138	File Read: No Data	An attempt was made to CREATE a file that already exists.
*	139	File Write	End of file read, or, for random access only, an attempt to read a portion of the file which had not been written.
*	140	File Position	A message from CDOS - an attempt was made to write to a write protected disk or an error occurred while writing to the disk.
NC	141	No Channel Available	An attempt was made to read a negative file record or record larger than 240K bytes.
HX	200	Invalid Hex Number	All I/O channels in use. (The maximum number of channels is system dependent.)
BO	201	Integer Overflow	Hexadecimal numbers must contain only the characters 0 through 9 and A through F.
			A value greater than 32767 was assigned to an integer variable.

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 20. Error Messages

FA	202	Function Arg Value	A function was called using an illegal argument. For example: SQR (-2).
IN	203	Invalid Input	An attempt was made to INPUT non-numeric data into a numeric variable.
IN	204	Input	An attempt was made to INPUT more items than were called for in the INPUT instruction.
DM	205	Not Dimensioned	A reference was made to a subscripted variable which had not been dimensioned.
ND	206	No Data Statement	An attempt was made to READ past the end of the DATA supplied. Either there was a READ with no DATA statement or there were not as many items in the DATA statement as in the READ list.
DT	207	Data Type Mismatch	An attempt was made to READ a numeric value to a string variable or vice versa. For example: <code>10 DATA 5 20 READ A\$</code>
E#	208	Number Size	An attempt was made to assign a value outside of the range 9.99E+62 to 9.99E-65 to a variable.
LL	209	Line Length	A line longer than 132 characters was entered.
*	210	Input Timeout	See the SET instruction for information about this error.

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20. Error Messages

OV 250 Overflow/
 Underflow

A floating point operation produced a number outside of the range 9.99E+62 to 9.99E-65. For example: $A=1/0$. Or, Integer arithmetic caused results outside of the range -32768 to 32767.

Note:

The character * in the Stand Alone BASIC Error Code column indicates that the error message is not applicable.

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ASCII CHARACTER CODES

DEC.	HEX	CHAR.	DEC.	HEX	CHAR.	DEC.	HEX	CHAR.
000	00	NUL (CTRL-@)	043	2B	+	086	56	V
001	01	SOH (CTRL-A)	044	2C	,	087	57	W
002	02	STX (CTRL-B)	045	2D	-	088	58	X
003	03	ETX (CTRL-C)	046	2E	.	089	59	Y
004	04	EOT (CTRL-D)	047	2F	/	090	5A	Z
005	05	ENQ (CTRL-E)	048	30	Ø	091	5B	[
006	06	ACK (CTRL-F)	049	31	1	092	5C	\
007	07	BEL (CTRL-G)	050	32	2	093	5D]
008	08	BS	051	33	3	094	5E	^
009	09	HT	052	34	4	095	5F	<
010	0A	LF	053	35	5	096	60	·
011	0B	VT	054	36	6	097	61	a
012	0C	FF	055	37	7	098	62	b
013	0D	CR	056	38	8	099	63	c
014	0E	SO (CTRL-N)	057	39	9	100	64	d
015	0F	SI (CTRL-O)	058	3A	:	101	65	e
016	10	DLE (CTRL-P)	059	3B	;	102	66	f
017	11	DC1 (CTRL-Q)	060	3C	<	103	67	g
018	12	DC2 (CTRL-R)	061	3D	=	104	68	h
019	13	DC3 (CTRL-S)	062	3E	>	105	69	i
020	14	DC4 (CTRL-T)	063	3F	?	106	6A	j
021	15	NAK (CTRL-U)	064	40	@	107	6B	k
022	16	SYN (CTRL-V)	065	41	A	108	6C	l
023	17	ETB (CTRL-W)	066	42	B	109	6D	m
024	18	CAN (CTRL-X)	067	43	C	110	6E	n
025	19	EM (CTRL-Y)	068	44	D	111	6F	o
026	1A	SUB (CTRL-Z)	069	45	E	112	70	p
027	1B	ESC (CTRL-[)	070	46	F	113	71	q
028	1C	FS (CTRL-\)	071	47	G	114	72	r
029	1D	GS (CTRL-])	072	48	H	115	73	s
030	1E	RS (CTRL-^)	073	49	I	116	74	t
031	1F	US (CTRL-_)	074	4A	J	117	75	u
032	20	(SPACE)	075	4B	K	118	76	v
033	21	!	076	4C	L	119	77	w
034	22	"	077	4D	M	120	78	x
035	23	#	078	4E	N	121	79	y
036	24	\$	079	4F	O	122	7A	z
037	25	%	080	50	P	123	7B	{
038	26	&	081	51	Q	124	7C	|
039	27	'	082	52	R	125	7D	}
040	28	(	083	53	S	126	7E	~
041	29	)	084	54	T	127	7F	DEL
042	2A	*	085	55	U			

LF=Line Feed FF=Form Feed CR=Carriage Return DEL=Rubout
 ESC=ESCAPE

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OVERLAY STRUCTURE

These programs demonstrate the ability of Cromemco's 16K Extended BASIC to overlay or have one program overlay (part of) itself with another. This feature is very useful for running large programs on smaller systems.

Space is most efficiently used if the same line numbers are used in all programs which are to be overlaid. In the following example, program ONE is run and calls in program TWO.

PROGRAM "ONE"

```
1 GOTO 10
5 ENTER "TWO"
10 DATA 1,2,3,4,5,6,7,8,9
20 READ A,B,C,D,E,F,G,H,I
30 GOTO 5
```

PROGRAM "TWO"

```
10 X=A+B+C+D
20 Y=E+F+G+H+I
30 Z=X+Y
40 PRINT X,Y,Z
50 END
```

>>ENTER "ONE"

>>RUN

10	35	45
50 END		

When program ONE is entered and RUN, line 1 passes control to line 10. Then at line 20, the DATA from line 10 is READ into variables A through I. Control is then passed to line 5 which calls in the second program. Program TWO overlays lines 10, 20, and 30. The line which follows line 5 is line 10. Now, however, line 10 is a line from program TWO. The rest of program TWO is executed with the results being printed out by line 40.

AUTOMATIC STARTUP AND
PROGRAM EXECUTION FROM CDOS

A very powerful feature of the Cromemco Disk Operating System (CDOS) is the ability to enter directly into an application program when powering up the computer. This is especially useful for the inexperienced user as there is no need to deal with any of the commands which are used to load and execute a program.

If, for example, the user wants to execute the BASIC program 'START.SAV' automatically when CDOS is entered, the following steps should be followed:

1. Make sure that there is a copy of the batch command file '@.COM' on DISK A.
2. Save the BASIC program you want RUN in a file (in this example we are using 'START.SAV'). The program must be SAVED (not LISTed) in order for this to work! Our program for this example is:

```
100 REM THIS IS MY
105 REM APPLICATION PROGRAM!
110 A=5
120 B=10
130 PRINT "THE ANSWER IS: "; A*B
140 END
```

3. Using the editor, create a file named 'STARTUP.CMD' on a disk A. Note that this must be named 'STARTUP.CMD' as this is the file name that CDOS looks for. In this example, the command file should contain the line:

BASIC START.SAV

Then, when CDOS is entered, the batch command will call BASIC which will RUN the saved program 'START.SAV'.

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4. When the computer is turned on and CDOS is entered (you have to hit the carriage return several times), our example will output the following:

CROMEMCO CDOS VERSION XX.XX

A.@ STARTUP
BATCH VERSION XX.XX

A.BASIC START.SAV

CDOS 16K BASIC, VERSION X.XX

THE ANSWER IS: 50

140 END

5. If the first program line is a NOESC or ONESC, the user can be prevented from ever leaving the running BASIC program.

MIXED MODE ARITHMETIC

There are three types of numbers in BASIC, Integer Short Floating Point (SHORT), and Long Floating Point (LONG), (hexadecimal constants are treated as integers). Any arithmetic computation, assignment, INPUT, or READ can be performed using any one or more of these types of numbers.

An assignment, READ, or INPUT will automatically convert the number to the type of the receiving variable. This is the variable which is on the left of the equal sign in an assignment instruction, and in the data list in the READ and INPUT instructions.

In general, numbers are converted to other types freely as needed. For example:

SIN (30) works, even though the SIN function must have a LONG argument. The Integer 30 is converted to a Long Floating Point number.

SYS (2.6) works, even though the SYS function must have an Integer argument. The Long (or Short) Floating Point number 2.6 is converted to an integer (rounding to 3.0).

Most problems will occur with mixed mode arithmetic involving Integer numbers. Remember that all constants without a decimal point and with a value less than 10,000 are stored as Integers.

Examples:

```
>>SHORT S
>>INTEGER I
>>S = 6 : I = 1
>>S = I / 3 * S
```

This example will assign a value of 0 to S. This is because I/3 is evaluated first (rules of

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precedence, arithmetic operators). Because both I and 3 are Integers, I/3 is evaluated as a 0 using Integer arithmetic. Zero times anything, no matter what type, is still 0.

```
>>SHORT S
>>INTEGER I
>>S = 6 : I = 1
>>S = S * I / 3
```

This example will assign a value of 2 to S. This time S*I is evaluated first, and because this is mixed mode arithmetic, the shorter form is converted to the longer form (I's value is converted to SHORT). Then S*I is equivalent to 6.0*1.0 or 6.0. We are left with 6.0/3, mixed mode again.

The Integer 3 (the shorter type) is converted to Short Floating Point (the longer type) and the division is performed. S is assigned a value of 6.0/3.0 or 2.0.

```
>>INTEGER S
>>SHORT S
>>LONG L
>>I = 1 : S = 3 : L = 1
```

If at this point we give the command:

```
>>L = L/S
```

L will be assigned a value of 0.333333333333333 because L/S is evaluated as Long Floating Point (the longer type).

If instead we have given the command:

```
>>L = I/S
```

L would have been assigned the value of 0.333333000000000 because I/S is evaluated as Short Floating Point (the longer type, but still only 6 digits of accuracy) and then assigned to a Long Floating Point variable (L) with 14 digits of accuracy.

Conversion of both types of floating point numbers to Integer numbers and vice versa does take time. Also Arithmetic, indexing, and subscripting with floating point numbers is much more time consuming

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than it is using Integers.

Time can be saved by using Integer numbers wherever possible. Where it is not possible, care in precedence ordering can result in significant time savings. If L is type LONG and I is type INTEGER, the first of the following commands will execute faster than the second one.

```
>>L = I*I*I*I*L  
>>L = L*I*I*I*I
```

This is because, until the last multiplication, the first example is using Integer arithmetic. The second example uses Long Floating Point arithmetic from the start, because the LONG variable is at the left and this is where evaluation of this expression begins.

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PATCH SPACE

Disk Version: The only space available in the disk version of 16K BASIC for user patches is at hexadecimal locations 425 to 4FF and 103 to 1FF. The user can put and SAVE (using CDOS) a patched ROUTINE at these locations.

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CROMEMCO 16K EXTENDED BASIC
AREAS OF USER INTEREST

Notes:

1. XX stands for: 04 if you are using CDOS
80 if you are using SAB
2. CDOS is the Cromemco Disk Operating System
SAB is the BASIC Stand Alone Operating System
3. Many of these values may be changed by the SET instruction. If necessary, and with care, they may be changed with the POKE instruction. Refer to the Appendix section on Changing the number of I/O Channels for an example.

<u>Hex Address</u>	<u>No. of Bytes</u>	<u>Version</u>	<u>Description</u>
XX00	3	CDOS	A jump (JP) to the routine where BASIC uses the address of the bottom of CDOS to establish the top of user program space.
		SAB	A jump (JP) to the routine which uses repeated RETURN characters to initialize the baud rate. After baud rate is established, BASIC automatically "sizes" RAM memory (starting at location 0) to establish top of user program space.
XX03	3	Both	A jump (JP) to a point in BASIC equivalent to a request to enter a new program line. Does not destroy program currently in memory.

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XX06	3	Both	A jump (JP) to a point in BASIC equivalent to issuing a SCRatch command. Does not re-size memory.
XX09	3	Both	A jump (JP) to a point in BASIC equivalent to the point reached via the jump at XX00 <u>except</u> that memory sizing and baud rate initialization do not take place. <u>On entry here, HL register pair should contain the address to be used as top of user program space, and the A register should contain the number of file channels to allocate.</u>
XX0C	3	CDOS	An illegal instruction (FF Hex, actually a RST 38H), which CDOS traps and uses to display an error message.
		SAB	A jump (JP) to the "IL" (Illegal command) error message.
		Both	If a CROMEMCO monitor resides in PROM at E000 hex, these 3 bytes should be changed to a jump (JP) to the breakpoint handler in the monitor. In case of failure in BASIC, the breakpoint information thus displayed might prove extremely valuable.
XX0F	3	CDOS	A jump (JP) to the CDOS warm-start at address 0000. Used by the BYE command to return to CDOS.
		SAB	A jump (JP) to location E008 Hex, the warmstart point in the CROMEMCO monitor. Used by the BYE command to exit to the

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monitor. CAUTION: BYE should not be used in systems without a monitor.

XX12	2	Both	<p>The address pointer used by BASIC to locate the beginning of the Device Driver LIST. The user may use this address to find the DDLIST or may change it to force BASIC to use an alternate DDLIST.</p>
XX14	2	CDOS	<p>The address pointer to the beginning of the ERROR MESSAGE. The format of error messages in memory is as follows:</p> <p>3 Bytes -- Call to error printer 1 Byte -- Error number n Bytes -- ASCII message, terminated by a 00 byte.</p>
XX14	2	SAB	<p>The address pointer to the beginning of the ERROR MESSAGES. The format of error messages in memory is as follows:</p> <p>3 Bytes -- Call to error printer 2 Bytes -- The error code, second byte first.</p>
XX16	1	Both	<p>The maximum number of channels which can be allocated at one time. Each I/O channel occupies 192 bytes of memory.</p>
XX17	1	Both	<p>The default number of characters per line. BASIC is shipped with this byte = 80 decimal.</p>
XX18	1	Both	<p>The number of characters per TAB position. BASIC</p>

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			is shipped with this byte = 20 decimal.
XX19	1	Both	The character which is used as a rubout, default value is 5FH (underline).
XX1A	1	Both	Default type of numeric variables and constants where 1=Integer, 2=Short Floating Point, and 4=Long Floating Point. The default value is 4.
XX1B	1	Both	Line delete character. The default value is control-U.
XX1C	1	Both	The carriage return delay (number of nul characters sent after a carriage return). The default value is 0.
XX1D	4	Both	Backspace echo - must terminate with a 0. The default value is backspace, space, backspace, 0.

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DETERMINING THE ADDRESS OF A STRING

The address of any string may be determined as follows:

```
100 L=LEN(X$) : A=SYS(2)
or
200 A=SYS(2+0*LEN(X$))
```

When the length of a string is taken, its address is automatically placed in SYS(2). CAUTION: SYS(2) is also used to store the most recent I/O character (to console or file). So don't mix usages of the address capability with I/O statements, including TRACE. It is probably best to put the two statements on a single line or statement, as shown.

NOTE: In the unlikely event that a program is using SYS(2) in its old sense of "last character", only the least significant byte of SYS(2) receives the character. The most significant byte may be reset via SET 2,0, or masked off via BINAND (SYS(2),255).

Another Caution: Adding (or ENTERing) new statements or variables can cause string addresses to change. Use SYS(2) just before you need the address (typically for a USR call). You could even do the following:

```
A=USR(%430%,LEN(A$),SYS(2))
```

to pass the address and length of a string.

Also, A=LEN(A\$(B)) : S=SYS(2) produces the address of the Bth character of the string A\$.

ADDING DEVICE DRIVERS TO BASIC

Declaring Device Drivers

All I/O devices to be accessed from BASIC must be declared in the device driver list. This list starts at location DDLIST and each entry is 8 bytes long. These entries are of the following form:

byte 0	device name (ASCII) first letter	second letter	byte 1
	base address of device letter		
2	LSB	MSB	3
4	may be used for device dependent information needed by driver		5
6	reserved		7

The device name (bytes 0 and 1) is used for finding the correct device to OPEN. For example, OPEN\2\"\$LP" would instruct BASIC to search the device driver list for device name "LP" (the \$ indicates a device instead of a disk file). The driver's starting address occupies the next two bytes. Actual addresses and equated value may vary depending on both revisions and which version of BASIC is being used. The following two bytes are reserved for use by the driver and their function(s) are defined by the person programming the driver. This device driver list can be placed in PROM. These two bytes are thus not intended as temporary storage areas.

A typical use of one of these bytes might be to hold the actual device address to be accessed. This would, for example, allow a general purpose TU-ART driver to drive several ports each dedicated to a different device.

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The last two bytes of each table entry are reserved for future use. The table itself is terminated by the first nul driver name (Hex 00 in the first character of the name).

Rules for Device Drivers

The actual device drivers must follow certain prescribed rules. In particular, the first 16 byte locations in the driver must contain address pointers to the various routines (some of which are required) in a BASIC driver. The 16 bytes define the addresses of 8 different routines as shown in the following table:

	(LSB)	(MSB)	
Byte 0	address of OPEN routine		Byte 1
2	address of CLOSE routine		3
4	address of SET STATUS routine		5
6	address of GET STATUS routine		7
8	address of PUTC routine		9
10	address of GETC routine		11
12	reserved (should be 0)		13
14	reserved (should be 0)		15

If any of the routines noted above are not defined for a given driver, the corresponding address field should be set to 0000H. However, if a routine is (or must be, see below) defined but does not do anything, the corresponding address must contain the address of an XOR A/RET instruction sequence.

A description of what must be accomplished by the various routines follows. Parameters which may (or must) be passed between BASIC and the driver routines are always passed in registers, or in the Extended File Control Block (EFCB).

Most of the information needed by the driver subroutines may be obtained from (or saved in) the

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Extended File Control Block (EFCB).

Register usage is covered in the description of each command routine below:

OPEN: This routine should perform any processing required to initialize the device. For example, a line printer driver would typically issue a form feed on open.

On Entry: (A') = no. of parameters (0,1,or 2)
(IY) = ADDR of EFCB
0, 1, or 2 parameters are passed to the routine in locations EFCBP1 and EFCBP2 of the EFCB.

On Return: A not equal to 0 says can't open. This is a user-trappable run time error.

CLOSE: This routine should perform processing necessary to "shut down" the device. For example, a paper tape punch driver might punch out a trailer piece of tape.

On Entry: (IY) = ADDR of EFCB

On Return: A not equal to 0 says can't close. This is a user-trappable run time error.

PUTC:

GETC: These routines perform byte-by-byte transfers to and from the device. Devices requiring a buffer may use the buffer (and/or extended buffer) in the EFCB.

On Entry: (IY) = ADDR of EFCB
(A) is character to be written (PUTC only)

On Return: (A) used for character read (GETC only)

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SSTAT: (SPOS)

This routine is used to set the status of the device. For example, a DAZZLER driver might use this to set the X/Y screen position.

On Entry: (A') = no. of parameters (0,1,or 2)
(IY) = ADDR of EFCB
0, 1, or 2 parameters are passed to the routine in locations EFCBP3 and EFCBP4 of the EFCB.

On Return: A not equal to 0 says invalid status request. This is a user-trappable run time error.

GSTAT: (GPOS)

On Entry: (IY) = ADDR of EFCB
(A') = which status is requested

On Exit: (HL) contains appropriate status value. A not equal to 0 sets a user-trappable runtime error.

NOTE: Registers IX and IY cannot be changed by any of these routines.

The EFCB referred to has the following format:

EFFCB	:	DS 1	;0=not in use, 1=in use
EFCBDA	:	DS 2	;Device Driver Address, ;bytes 2&3 From DDLIST
EFCBDD	:	DS 2	;Device Dependent info, ;bytes 4&5 from DDLIST
EFCBP1	:	DS 2	;\These are the two optional ;parameters
EFCBP2	:	DS 2	;/P1 & P2 as used in the ;"OPEN" statement
EFCBP3	:	DS 2	;\These are the 2 optional ;parameters P1 & P2
EFCBP4	:	DS 2	;/used in PUT, GET, PRINT, ;and INPUT statements
BUFFER	:	DS 179	;Available to user for ;accumulating individually ;passed bytes into a buffer

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When the proper DDLIST entries have been made as shown, operation of the driver is as follows:

OPEN\1,A,B,\\$"DR"	Calls the OPEN routine of driver "DR". EFCBP1 = A, EFCBP2 = B A' register = 2, IY = ADDR of EFCB If OPEN is not needed, it must consist of an XOR A, RET sequence.
PRINT\1,X,Y\"HELLO\"	The Set Status routine of "DR" is called with EFCBP3 = X, EFCBP4 = Y (X and Y are converted to integers first). A' = 2, IY = ADDR of EFCB An XOR A, RET sequence should be executed at the completion of Set Status. Next, the PUTC routine of "DR" is called 7 times, once for each character to be transmitted plus once with a Carriage Return and once with a line feed. A = character, IY = ADDR of EFCB
INPUT\1\A\$	Set Status routine of "DR" is called with EFCBP3 = %FFFF%, EFCBP4 = %FFFF%, A' = 0, IY = ADDR of EFCB An XOR A, RET sequence should be executed. Next, the GETC routine of "DR" is called repeatedly, expecting one byte to be returned in A. This continues until a terminator (CR,LF,FF,NULL) is transmitted, or until more than 132 characters have been transmitted.
A = IOSTAT(1,n) where <u>0</u> ≤ <u>n</u> ≤255	The Get Status routine of "DR" is called. A' contains n, the requested status parameter and IY = ADDR of EFCB. The status value to be returned should be placed in HL. An XOR A, RET sequence should be executed last.
CLOSE\1\	The CLOSE routine of "DR" is called. If CLOSE is not needed, an XOR A, RET sequence must be provided.

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Note that if PUT and GET were used in the above calls instead of PRINT and INPUT, binary bytes would be transmitted according to variable type and no carriage control information would be sent. I.E., PUT\l\V would transmit two bytes if V is an integer, four bytes if V is short floating point, and eight bytes if V is long floating point. No carriage return or line feed is sent. Also note that PRINT\l\"A","B" will not transmit the comma but will send the proper number of spaces to place "B" in the next tab field.

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DDLIST (DEVICE DRIVER LIST)

<u>ADDR</u>	<u>CODE</u>			
		; NOTE: THE ADDRESSES SHOWN IN THIS LISTING		
		; MAY VARY FROM VERSION TO VERSION, but the		
		; format is identical. The actual starting		
		; address may be found in locations 0412,		
		; 0413 for CDOS BASIC and 8012, 8013 for		
		; Stand Alone BASIC		
		DDLIST:		
4B6C	53	DDCNSL	DB	'SY' ; 'SYSTEM' = CONSOLE
4B6D	59			
4B6E	E84A		DW	DRTUART
4B70	00		DB	0,0
4B71	00			
4B72	00		DB	0,0
4B73	00			
4B74	54		DB	'T5' ; 2ND TUART PORT
4B75	35			
4B76	E84A		DW	DRTUART
4B78	50		DB	50H,50H ; BOTH BYTES GET ADDR ; OF 2ND TUART
4B79	50			
4B7A	0000		DW	0 ; RESERVED BY SYSTEM
		;		
		; CDOS SYSTEM PUNCH READER, AND LIST DRIVERS		
4B7C	50		DB	'PU'
4B7D	55			
4B7E	9C4A		DW	DRCDPU ; CDOS PUNCH DRIVER
4B80	0000		DW	0
4B82	0000		DW	0
4B84	52		DB	'RD'
4B85	44			
4B86	B54A		DW	DRCDRD ; CDOS READER
4B88	0000		DW	0
4B8A	0000		DW	0
4B8C	4C		DB	'LP'
4B8D	50			
4B8E	CA4A		DW	DRCDLP ; CDOS LIST DRIVER
4B90	0000		DW	0
4B92	0000		DW	0
4B94	00	DDEND:	DB	0 ; END OF DDLIST-NOTE: ; IF DDLIST IS ; EXTENDED, THIS NULL ; should be overwritten ; and then placed at

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4B95 ; DEFS 64 end of the new DDLIST
 ;RESERVE SPACE FOR
 ;MORE DRIVERS

CDOS PUNCH, READER, AND LIST DRIVER INTERFACES

<u>ADDR</u>	<u>CODE</u>	; SAMPLE DEVICE DRIVERS		
		;		
		; PUNCH		
		;		
		DRCDPU:		
4A9C	E64A	DW	\$DUMMY	
4A9E	E64A	DW	\$DUMMY	
4AA0	E64A	DW	\$DUMMY	
4AA2	E64A	DW	\$DUMMY	
4AA4	AC4A	DW	\$PUPC	;PUNCH OUT CHARACTER
4AA6	0000	DW	0	
4AA8	0000	DW	0	
4AAA	0000	DW	0	
		;		
4AAC	5F	\$PUPC:	LD E,A	;GET CHAR TO E REG AS
			LD C,4	;CDOS EXPECTS
		\$PULPJ:		;CDOS PUNCH ENTRY
4AAF	F5	PUSH AF		
4AB0	CD0500	CALL CDOS		
4AB3	F1	POP AF		
4ABF	C9	RET		
		;		
		;		
		DRCDRD:		
4AB5	E64A	DW	\$DUMMY	
4AB7	E64A	DW	\$DUMMY	
4AB9	E64A	DW	\$DUMMY	
4ABB	E64A	DW	\$DUMMY	
4ABD	0000	DW	0	
4ABF	054A	DW	\$RDGC	;RDR GET CHAR ROUTINE
4AC1	0000	DW	0	
4AC3	0000	DW	0	
		;		
		\$RDGC:		
4AC5	0E03	LD C,3		;CDOS READER GETC
				;ENTRY PARM
		JP CDOS		;READY TO GO... CHAR
				;RTND IN A

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DRCDLP:				
4ACA	DF4A	DW	\$LPOP	;OPEN ROUTINE
4ACC	E64A	DW	\$DUMMY	
4ACE	E64A	DW	\$DUMMY	
4AD0	E64A	DW	\$DUMMY	
4AD2	DA4A	DW	\$LPPC	;AND LP PUTC ROUTINE
4AD4	0000	DW	0	
4AD6	0000	DW	0	
4AD8	0000	DW	0	
\$LPPC:				
4ADA	54	LD	E,A	;MOVE CHAR TO E
4ADB	0E05	LD	C,5	;CDOS LIST WRITE
				;ENTRY PARM
4ADD	18D0	JR	\$PULPJ	
\$LPOP				
4ADF	3E0C	LD	A,ASCFF	;ISSUE A FORM FEED ON
				;OPENING FILE
4AE1	CDDA4A	CALL	\$LPPC	
4AE4	AF	XOR	A	
4AE5	C9	RET		;RET WITH 0 STATUS
\$DUMMY:				
4AE6	AF	XOR	A	
4AE7	C9	RET		

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ACCESSORY I/O DRIVERS

The DDLIST contains five drivers which may be accessed by the user. BASIC treats these drivers as files. They must therefore be OPENed and CLOSED, but may not be CREATED (because they already exist). Note that the first three drivers are not available in the Stand Alone version of BASIC.

Line Printer Driver

The system line printer can be accessed by OPENing a file named \$LP. This driver uses the CDOS system call to output data to the line printer. INPUT and GET instructions must not be used with this file.

Punch Driver

The system punch may be accessed by OPENing a file named \$PU. This driver uses the CDOS system call to output data to the punch. INPUT and GET instructions must not be used with this file.

Reader Driver

The system reader may be accessed by OPENing a file named \$RD. This driver uses the CDOS system call to input data from the reader. PRINT and PUT instructions must not be used with this file.

Console Driver

The system console may be accessed by OPENing a file named \$SY. This driver bypasses CDOS and allows the user to input and output data from/to

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the console directly by using port 0 (UART status) and port 1 (UART data).

TU-ART Driver

There is a general purpose TU-ART serial I/O port driver in the DDLIST called T5. It assumes a TU-ART addressed at port 50H and may be used for any serial device provided the baud rate is initialized prior to its use with an OUT instruction.

Example:

```
10 OUT %50%,4 : REM SET TU-ART TO 300 BAUD
20 OPEN\2\"$T5" : REM SETS UP DEVICE #2 FOR SERIAL I/O
```

The driver for the system console at port 0 is labeled "\$SY". To switch between the console and a second terminal:

```
20 OPEN\1\"$SY"
30 OPEN\2\"$T5"
```

This will allow you to later say PRINT\A\"MESSAGE", where A can be changed via software to be 1 for the console and 2 for another terminal.

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CHANGING THE NUMBER OF I/O CHANNELS

BASIC carries 4 I/O channels in addition to the console. One I/O channel is needed for each file which is OPENed at the same time. Each I/O channel occupies 192 bytes of memory.

If you wish to change the number of channels in use, type the following commands while in BASIC:

<u>Disk System</u>	<u>Stand Alone System</u>
POKE%416%,X	POKE%8016%,X
A=USR (%400%,0)	A=USR (%8000%,0)

where X is the number of I/O channels desired in addition to the console. The POKE command puts the number of channels desired into the proper location and the USR function reinitializes BASIC.

On a disk system, you can now save this new version of BASIC by returning to CDOS and typing:

>>BYE

A.SAVE BASIC1.COM 76

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LOADING 16K BASIC FROM PROM

I. Memory Requirements:

1. 16K PROM starting at location 8000H.
2. At least 8K RAM starting at location 0.

II. System Set Up:

A. CROMEMCO 8K BYTESAVER II PROM board:

1. Turn PROM program power switch 'OFF'.
2. Turn program enable switches 'OFF'.
3. Plug the 16 CROMEMCO 16K BASIC PROMs into the boards in numerical order.

board one -
8000 into PROM socket 0
8400 into PROM socket 1
etc.

board two -
A000 into PROM socket 0
A400 into PROM socket 1
etc.

4. Set LOGICAL ADDRESS BLOCK SELECT to 8000H & A000H

BYTESAVER II switches:

board one - 15=1, 14=0, 13=0
board two - 15=1, 14=0, 13=1

B. 16KPR board:

1. Set LOGICAL ADDRESS BLOCK SELECT to 8000H.

switch 15=1
switch 14=0

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2. Plug the 16 CROMEMCO 16K BASIC PROMs into the board in numerical order.

8000 into PROM socket 0
8400 into PROM socket 1
etc.

III. All systems:

1. Set the jump start address on the ZPU board to 8000H.

Switch A15=1
A14=0
A13=0
A12=0

2. Select bank 0 on the PROM board (switch 8 on).

IV. Method:

1. Depress the return key on the console several times so that CROMEMCO 16K BASIC can determine the baud rate of your terminal.
2. CROMEMCO 16K BASIC will respond with a prompt (>>) to indicate that it is ready to accept a command.
3. Refer to the section on Getting Started for information on how to proceed from this point.

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